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# AGRICULTURAL JOURNAL

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## EDITORIAL.

IT should be noted that this number is the first issue of Volume 4 of the *Agricultural Journal* and that Volume 3 was completed by the third number published in October, 1930.

*Agricultural Convention.*—This function was opened by His Excellency the Governor on October 7th, 1930, when a large and representative gathering met in the new Fiji Museum. The subjects considered during the three days devoted to the Convention included dairying, the copra industry, banana production and export, noxious weeds, and minor crops. Contributions to the discussions came from all sections of the agricultural community, and information of value was obtained. The wider basis on which the Convention was organised should enhance its usefulness, and the addresses by those gentlemen who so kindly consented to introduce the different subjects evidenced deep study and a wide appreciation of the agricultural activities of the Colony. The proceedings of the Convention are published in this issue.

*Bananas.*—The new arrangements for inspection of bananas at the wharf continue to work well, and it is gratifying to record that reports from Auckland state that the quality of the fruit now shipped is excellent. Good prices have been obtained for recent shipments. The handling of cased fruit on the wharf has been greatly facilitated by the use of Morris Conveyors, which should considerably reduce damage by shaking and bruising. The output of bananas has received a further setback by three storms, the first of which occurred on November 23rd, 1930, and affected principally the Wainibuka district, while the others occurred very close together in late February and early March, 1931, and affected much wider areas. At the time of writing it has not been possible to ascertain the actual extent of the damage to bananas and other growing crops, but it is known to be serious and it is feared that fruit exports will be considerably below normal for some months. The banana districts which suffered were the Wainibuka, Wainimala and, to a lesser extent, the Waidina Rivers. The output from the island of Kadavu has increased rapidly and it is expected that the monthly export will soon reach 2,000 cases.

Banana Buyers' Licences, excepting the one issued for the province of Kadavu, expired on the 31st December, 1930. New licences have been issued for all other areas, excepting Ovalau, Moturiki and Gau. A few minor changes have been made, particularly in regard to the Waidina River, which is now shared by the Dominion Fruit Company and the Waidina Banana Syndicate (Messrs. Barber, Abbott and Message). The island of Koro and portion of the Savusavu magisterial district have been proclaimed under the Fruit Export Ordinance and licences will be issued for these areas.

*Animal Health.*—The discovery of a species of tick (*Hæmaphysalis bispinosa*) hitherto unknown in Fiji has rendered it necessary to restrict the movement of cattle in and from the area bounded by the Lower Rewa and Tamavua Rivers. The veterinary staff, assisted by a temporary staff, is engaged on the work of inspection and spraying of animals within the area in an endeavour to eradicate the tick. Fortunately, the tick is not a disease carrier, but it causes loss of condition in animals and is therefore objectionable.

## FIJI AGRICULTURAL CONVENTION.

*October 7th and 8th,* 1930.

*President.*—His Excellency Sir Murchison Fletcher, K.C.M.G.

*Chairman.*—A. C. Barnes, Esq., Director of Agriculture.

*Members of Committee.*—Edward Duncan, Esq., Fiji Show Association; J. L. Hunt, Esq., Fiji Planters' Association; Major Clive Joske, M.C., Coconut Planters' Union Limited.

*Secretary.*—N. G. J. McNally, Esq.

*Participating Bodies.*—Buca Bay Progress Association; Coconut Planters' Union Limited; Fawn Harbour Progress Association; Fiji Planters' Association; Fiji Show Association; Savusavu West Progress Association; Vanualevu Progress Association.

### AGENDA.

*Tuesday, October 7th,* 2.15 *p.m.*

1. Opening Address by His Excellency the Governor.

Motion No. 1.

2. " The Present Position and Prospects of the Dairying Industry in Fiji "—Address by J. Chapman, Esq.

Discussion opened by A. H. Witherow, Esq.

Motion No. 2.

*Wednesday, October 8th,* 9.30 *a.m.*

3. " The Copra Industry "—Address by E. Duncan, Esq., and Major Clive Joske, M.C.

Discussion opened by Sir Maynard Hedstrom.

Motion No. 3.—Major Willoughby Tottenham.

2.15 *p.m.*

4. " The Banana Export Industry "—Address by A. C. Barnes, Esq.

Discussion opened by A. H. Witherow, Esq.

5. " The Control of Noxious Weeds in Fiji "—Paper presented by A. C. Barnes, Esq.

Discussion opened by J. L. Hunt, Esq.

Motion No. 4.—E. Duncan, Esq.

6. Closing Address by His Excellency the Governor.

*Note.*—(1) Meetings will be held in the new Fiji Museum (Carnegie Library Buildings).

(2) Gentlemen who wish to take part in discussions are requested to notify the Secretary prior to the meetings.

(3) If time permits, the production and marketing of minor crops will be discussed.

### MOTIONS.

1. That in the opinion of this Convention it is desirable that the Agricultural and allied Associations of the Colony of Fiji should form themselves into a Convention of Associations which should hold an annual meeting to discuss and consider matters of interest to the primary industries of the Colony.

2. That this Convention appreciates the assistance afforded by Government to the dairying industry of the Colony by the increase and extension of the system of subsidies on pedigree and grade stock and welcomes the proposal to pay a subsidy on butter exported from the Colony.

3. That in the opinion of the Convention the position of the copra industry gives cause for disquietude and that the possibilities of securing increased returns to producers should be explored, such as by increase of yield, the reduction of production and transport costs, and the introduction of a system of Government grading.

4. That in the opinion of this Convention a more active campaign directed to the control of noxious weeds in Fiji should be pursued.

His Excellency the Governor in opening the Convention said that he had been present throughout the proceedings of the Conference which was held in January, 1930, and that he regarded these Conferences as of great importance to the welfare and progress of the Colony. It was a trite saying that without agriculture there would not be anyone in Fiji at the present day. There were many ways in which not only agriculture could be improved but also the means of marketing.

His Excellency then briefly referred to the Agenda and said that with regard to Motion 1 it was a most important preliminary step to form some central body so that there should not be isolated bodies coming as they did from time to time to the Government and asking for assistance. He had suggested to the Indian community that they themselves should form a separate Agricultural Association to place their difficulties before the Government.

He said he was intensely interested in the subject of the present position and prospects of the dairying industry in Fiji, and that he had taken the opportunity when in Sydney of making inquiries there. He felt confident that Fiji was at the beginning of a really important new industry. The Government would do all in its power to assist the dairying industry. He drew attention to the motion which dealt with the proposal to pay a subsidy on butter exported from the Colony. He mentioned that this matter was in the Budget coming before Legislative Council. He himself did not consider that the subsidy should be paid for an indefinite period or any too long a period. He drew attention to the Patterson Scheme in operation in Australia whereby every producer paid ½d. per ℔ on all butter produced. The selling price in Australia was fixed by the producer and the ½d. per ℔ which they paid to the fund enabled a bounty of 4d. per ℔ to be paid on all butter exported. He remarked that he had only casually investigated the Scheme but should like to follow it up for possible adoption in Fiji.

Speaking on the copra industry and the motion to be moved by Major Willoughby Tottenham His Excellency said that he did not agree with him as to the cause for disquietude. He concurred that at the moment t[illegible] bottom seemed to have fallen out of the market but on looking at figu[illegible], for 20 years ago he found that the same condition of affairs existed th[illegible]. He felt certain that Fiji was about to turn the corner. With an indus[illegible] such as this which was one of the most important industries of the world he felt certain that conditions would improve but it was quite true that we had to secure increased returns. He mentioned that this matter had been discussed at length at the January Conference, but he would like to hear further discussion on the question. His Excellency then referred to the motion dealing with a reduction of production costs and transport costs. Transport costs were at the root of everything in this Colony—

transport costs and means of communication. He said that although times were bad he was trying to push on with the road round the island but he was afraid that it was not possible to do much at present.

Speaking on the production of minor crops he remarked that the principal text of the note was connected with Motion No. 1, allied Associations and the question of transport. It was absurd that a Colony with such an excellent soil and climate capable of producing minor crops should find that there was absolutely no market for them. The Government with the assistance of the Director of Agriculture would explore every possibility of establishing some central marketing arrangements whereby the small producer could get a good price for his crops. He entirely agreed with this important motion.

With regard to the banana export industry His Excellency said that this was a matter of the greatest importance and it was unfortunate that there were diseases to contend with. The Government had seconded a Cadet who had a long training in agriculture in England, for the purpose of studying these banana diseases and he sincerely hoped that some advance would be made in their control. There were many questions of the greatest interest connected with the banana industry and one in particular was the system by which the purchase of Fijian bananas was carried on. There was also the question of the Indian growers to be considered. He hoped that the Convention would do something to indicate to Government the proper path to take. Speaking on the subject of control of noxious weeds His Excellency said that on " Koster's Curse " the Thrips were being tried and it was having some success. In connection with this matter there was the question of employing more labour and more mechanical appliances, ploughs, tractors and so on. His Excellency in conclusion expressed his regret that very great pressure of business would prevent him from attending throughout the whole of the sessions.

*Mr. Duncan* moved Motion No. 1 as follows:—

> That in the opinion of this Convention it is desirable that the Agricultural and allied Associations of the Colony of Fiji should form themselves into a Convention of Associations which should hold an annual meeting to discuss and consider matters of interest to the primary industries of the Colony.

Speaking to this motion Mr. Duncan said that this was the sort of Association that had been aimed at for many years. Dr. Tothill made a very strong effort to form one but unfortunately he was unsuccessful. He considered that the various Associations acting alone were not likely to achieve much success.

*Major Willoughby Tottenham* in seconding the motion said that he endorsed the necessity for such an Association.

*Mr. Barker* said that a similar suggestion had been made four or five years ago. The assistance of the Government had been obtained, and the Superintendent of Agriculture, Dr. Tothill had taken a keen interest. Rules had been prepared for a so-called Agricultural Society. Most of the Associations in question at that time favoured the proposal, but one district strongly objected, and on that account Dr. Tothill's efforts did not succeed.

*Major Joske* said that his Union was mainly concerned with marketing and shipping organisation, but that he was sure all members would heartily support the proposal. Most of the participating bodies with the exception of the Fiji Show Association and the Fiji Planters' Association were coconut planters' organisations and they would welcome the idea. The time might come when the Convention would go from district to district and perhaps the Government would place at its disposal the " Pioneer " so that meetings could be held in other places in the Colony.

*Mr. J. L. Hunt* stated that all the Associations, including the Planters' Association would be keen to join the Convention and form one body which would give the views of the Colony. This had been the aim of the Planters' Association for many years. He mentioned that there used to be a Convention of planters consisting of 196 members with branches in not less than five districts, but owing to lack of communication it was difficult to keep in touch with them all. He suggested that the meetings be held from time to time in different districts of the Colony.

*Mr. Barnes* said that a motion of this description did not mean that the Associations already existing would lose thier individuality. It was hoped that they themselves would continue to exist and extend but if they had some central controlling body they could go to Government backed by the general body of opinion, and this course would carry very much more weight. Under present circumstances Government received complaints, suggestions and recommendations from individual Associations such as those listed, but there was no proper communication between those individual Associations and the Government such as would be provided if a representative Convention were formed.

*His Excellency* said that he agreed with Mr. Barnes that it was not intended to do away with any of the separate Associations. He instanced Ceylon where they had both the individual Planters' Union and a Great Planters' Union of Ceylon. The district Association represented their views and difficulties to the parent body.

Motion No. 1 adopted.

*Mr. J. Chapman* addressed the Convention on the dairy industry as follows:—

I have been asked to prepare a paper on the " Present Position and Prospects of Dairying in Fiji." I speak with some diffidence: firstly, because my residence in Fiji has extended only for a period of six years; and secondly, because my experience in the dairying industry has been confined to the Navua district and I have very little knowledge of the condition of affairs in connection with the Rewa and Tailevu districts. Each district must have its own peculiar problems, but there are certain larger questions which must confront all dairy farmers in this Colony, as they have in the past confronted those engaged in the dairying industry in other countries.

*Improvement of Herd.*—I think probably the most serious problem is the question of improving the breed of cows so as to increase the production of butter fat. Most of the dairy herds in the Colony have been built up on the foundation of local cows. I know that at Navua we bought large numbers of Fiji-bred cows—most of them of no particular breed—many of them allied to beef breeds rather than to milking stock. On the basis of these local herds we are attempting to produce a herd of good milking cattle and with that object in view have imported a number of pedigree bulls, both of Jersey and Friesian breeds. We have now a considerable number of cows of the second generation (*i.e.*, three-quarter pure breed) and the improved results with this young stock are encouraging. We are building up two separate herds—one of them sired by Friesians and the other by Jerseys—and our intention is ultimately to eliminate the Fiji-bred cow of indeterminate descent. This can only be done by a process of selection and elimination and that process is going on steadily all the time, but up to the present the elimination has been done purely on observation and inspection, we have had no scientific method of herd-testing. After considering this question the Fiji Pastoral Company recently engaged a qualified herd-tester, recommended by the New Zealand Herd Testing Association, and he is at present engaged in tattooing all our cows, according to the New Zealand system, prior to starting a systematic test. It is hoped that by this method we will ascertain with some accuracy the cows which are proving unprofitable. They will be speyed and turned into the beef herd.

The Company's dairy herd consists of over 1,000 females and these are distributed in about equal proportion of Friesian strain, Jersey strain and local stock. We cannot state with any degree of accuracy what is the production of butter fat per cow, but our estimate is about 150 ℔ per cow per annum. If we can eliminate from the dairy herd, say, 20 per cent. representing the most unprofitable beasts in the herd the average production of those remaining will be substantially increased and we hope that the rejected cows will be replaced by three-quarter bred heifers which again should give a return considerably above the average of the whole herd. If we can increase the average production per head we will at the same time increase the average production of butter fat per acre of land—and that is the biggest problem which faces the dairy farmer in Fiji. With careful selection of sires and the scientific elimination of the unprofitable the average production of the herd must increase. This question is of first importance to every dairy farmer, whether his herd be large or small. The small farmer cannot engage his own herd-tester, but it would seem worth while to consider in each district some form of co-operation whereby the farmer may obtain accurate records of the individual production of each cow he is milking.

*Improvements of Pastures.*—The next most important problem is the improvement of our pastures so as to increase the carrying capacity and production of butter fat per acre. I am not qualified to speak with any authority regarding the fodder grasses of Fiji as my experience has practically been limited to two fodder plants—Para Grass and Sensitive Grass. Most of the land we are farming at Navua was formerly under sugar and, to some extent at least, before the sugar industry was finally abandoned the land was neglected and impoverished. When dairying operations were commenced an endeavour was made to preserve the para grass which was growing freely on all the flat land but in this effort we have not been successful. We have gone to considerable expense with the sub-division of paddocks and the extent of our fencing will be realised when I tell you that we have forty-seven miles of barbed wire cattle fencing. Notwithstanding this the area under para grass is steadily diminishing and its place has been taken by sensitive. On the low-lying Bila land which is constantly refreshed by flood water para holds its own—even with heavy feeding, but on the abandoned sugar land it succumbs very readily and, as I have said, its place is taken by sensitive. I was very apprehensive when I saw the gradual decrease of para and the increase of sensitive but I have become reconciled to that condition—the sensitive stands very heavy feeding, cattle take to it quite readily, and at present a very large percentage of the butter fat produced at Navua is produced from sensitive grass. I do not suggest that sensitive grass is an ideal cattle food. We have made experiments on a small scale with English grasses and with Paspalum, but the results have not been sufficiently encouraging to justify any heavy expenditure. It would be an excellent thing for the dairy farmers of this Colony if we could discover some grass which would flourish and afford a change of diet and pasture for the milking cows. I cannot help thinking that there must be tropical or semitropical grasses that would be suitable to our climate and I am looking forward with interest to the experiments contemplated by the Agricultural Department.

Linked up with this question of improvement of pasture is the question of manuring. We have made some small experiments with artificial manures and the results have been encouraging when coupled with a heavy stroke of the disc harrow—areas thus treated showing a marked and sustained improvement. Top dressing without discing does not yield any apparent result. We have not continued these experiments because we have felt that we are working in the dark and that we may easily spend a large amount of money without producing a proportionate return. We have not at our hand the scientific knowledge to decide what elements are missing in our soil and what class of manures should be used to give us the best return in cattle feed. We hope that later we may be able to get technical advice on this subject and I am sure that many dairy farmers will be glad to make small areas of land available for practical experiments with various classes of manures.

*The Control of Noxious Weeds.*—Our worst pest at Navua is that commonly known as " Koster's Curse." and I understand this is true also of the Rewa district and the Tailevu district. During the past few years we have spent many hundreds of pounds in an endeavour to eradicate this weed. On the main areas we have obtained some measures of control and the expenditure per acre for Curse cutting is very much lower now than it was two or three years ago. We still have a good deal of trouble on areas near our boundary lines because in most cases our neighbours take very little interest in the eradication of this weed and from neighbouring lands the seeds are freely replanted in our fields. I know the Agricultural Department is taking great interest in this question and it would greatly improve the prospects of the industry if we were able to find some natural enemy for this Curse. By the courtesy of the Agricultural Department we have started two colonies of Thrips at Navua but the time which has elapsed has not been sufficient to disclose whether any useful work is being done

*Milking Machines.*—In Fiji, as in New Zealand, opinions differ as to the advisability of machine milking. My opinion is that in New Zealand the argument is in favour of the machine, but my experience at Navua has led me to form the opinion that as long as Indian milkers are obtainable we get better results from hand-milking than from machine-milking. We had machines installed in three sheds but have dismantled them and packed them away. To obtain superfine cream from machine milkers one must have the most meticulous care and cleanliness and I have not been able to obtain this from Indian assistants. To run milking machines efficiently I consider they must be under close European supervision and as we have eight milking-sheds scattered over a radius of about three miles from the factory, European supervision would be expensive.

*Government Assistance.*—The Government has already shown its interest in the industry and in one particular district has expended a very substantial amount of money in its development. There are some directions in which we must naturally look for Government assistance and support:—

(*a*) I understand the Government is contemplating a bonus on butter exported and the creation of a Butter Control Board. Provided all interests are represented on the Board I think this will be a very wise move;

(*b*) the Agricultural Department, as I have mentioned earlier, is taking a keen interest in finding some method of economically controlling " Koster's Curse ";

(*c*) the Agricultural Department is considering by-laws to govern milking sheds, factories, &c. So long as these are reasonable and do not at once set too high a standard they are likely to be productive of good, but we must learn to walk before we can run;

(*d*) the Government is interested in the improvement of stock and has made provision to assist importers who desire to introduce pedigree stock;

(*e*) I hope the Government will take a keen interest in the question of the improvement of our pastures, both in the direction of experimenting with new grasses and technical consideration on the subject of manures.

*The Future of the Industry.*—I think that we must judge the prospects of the future largely by the history of the past. According to records kept by the Agricultural Department the following figures show the production of factory butter in Fiji for the past nine years:—

| *Year.* | *Amount.* (℔) |
|---|---|
| 1921 | 15,104 |
| 1922 | 23,785 |
| 1923 | 59,219 |
| 1924 | 143,219 |
| 1925 | 168,844 |
| 1926 | 247,724 |
| 1927 | 295,677 |
| 1928 | 307,989 |
| 1929 | 392,214 |

The percentage increase is not likely to be as great in the future as in the past, but there is every prospect of a steady, solid advancement year by year. In the Rewa district particularly, considerable enterprise has been shown in the introduction of high grade stock and this must have in the very near future a substantial effect on our production. We have substantial areas of land on this island which can be made suitable for cattle grazing and for dairying which otherwise would lie useless and covered with weeds. Such land is obtainable at moderate rentals so that the dairy farmer in Fiji has at least that advantage over the New Zealand dairy farmer. I suggest that the work of the past nine years has demonstrated:—

(*a*) that various breeds of dairy cattle can readily be acclimatised here and remain as healthy and free from disease as in any other part of the world;

(*b*) that the progeny of imported stock (provided thay are suitabably mated) are superior to their sires and dams, probably because they do not need to undergo the process of acclimatisation;

(*c*) that high grade butter, suitable for export to any market, can be produced in this Colony.

Having these three factors fixed I think it only needs energy intelligently applied to insure the steady progress of the industry.

In conclusion, I should like to say that I am more favourably impressed to-day with the chances of success that I was when first I arrived in the Colony.

*Mr. A. H. Witherow* in opening the discussion said the production of the maximum quantity of butter fat was of prime importance and this could only be done by good feeding and by having pedigree bulls with high butter fat backing. Herd testing was also very necessary. The dairying industry was suffering from great drawbacks. There were the absence of varieties of good fodder plants for our pastures, the difficulty in obtaining land at reasonable rentals, and the obstacle of noxious weeds. Mr. Witherow then touched on the question of cheese making and said that with a little protection from the Government this could be carried out quite profitably.

*Mr. Meek* considered that ghee-making should be investigated. Another point he would like to mention was the enormous loss to the dairy farmers through carrying in their herds diseased animals.

*Mr. McElwaine* said that he had been interested in dairying since its inception in the Colony and he considered that pasture was the most important thing that was holding back the progress of dairying within the Colony. He said that another important point was the subsidy paid by the Government on pure bred bulls and cows which was £10 per head. This sum practically covered the whole of the expense of bringing the animal from New Zealand with the result that dairymen in Fiji are on the same footing as dairymen in New Zealand More rapid transport of cream from farm to factory was necessary.

*Mr. Turbet* said he shared with the previous speakers the optimism for the future of the dairying industry. He remarked that he would support at least the temporary appointment of an official herd-tester. With regard to pure bred bulls, Geneticists and animal breeders had found that a bull transmits his ability for milk producing to the female line rather than to the male line and that a bull should not therefore be judged on his pedigree but by the results of his heifers. Mr. Turbet went on to say that for many years experiments in connection with pasture grasses from temperate zones had been carried out by the Agricultural Department and private individuals and sufficient information had been gathered to say that these countries had no grasses suitable for our conditions. It was necessary to turn to tropical and sub-tropical climates such as Hawaii, and the Philippines. He mentioned that there were two serious diseases in the dairy herds, tuberculosis and contagious abortion. A move had been made to eradicate tuberculosis from the registered dairies in the Suva district. Rules were being drawn up for compulsory testing for tuberculosis. This was only a beginning but before long he hoped to see it extended to the three areas supplying milk to the factories. Contagious abortion was chiefly apparent at Navua, but it was also on some of the Tailevu farms and on at least one Rewa farm. Steps were being taken to control the disease restricting the movement of cattle from the affected farms. He said that the efforts had been fairly successful and he hoped that eventually the disease would be eliminated.

*Mr. Fernandez* discussed the freight on exported butter. The Union Company charged 3s. 9d. per box from Suva to Auckland and the freight from Auckland to England was 3s. 6d. With regard to the production of butter at the Rewa Factory he said that in 1925, 58,000 ℔ of butter were manufactured at a cost of 4¼d. per ℔, for the year ended 1927, 104,000 ℔ at a cost of approximately 3¼d. and for the year ending June, 1930, 133,000 ℔ at a cost of 2¼d. Thus the larger the production the lower is the cost of manufacture. He considers that unless the Government made herd-testing compulsory it would never be carried out in Fiji.

*Mr. Stuchbery* said that he considered the use of concentrated foods as a matter of importance in Fiji because our only fodder plants were very bulky foods and the cattle did not always get the amount of nutriment that they could assimilate in the production of their butter fat. He mentioned that although they had experienced a dry season on the Western side of Vitilevu the Colonial Sugar Refining Company had maintained their production of butter fat by the use of cotton seed. The Colonial Sugar Refining Company were carrying out experiments with top dressing and he was much impressed with their efforts.

Convention adjourned until 9.30 a.m. on Wednesday, 8th October.

### *Thursday, 9th October.*

*Mr. Barnes* in reopening the Convention said that he would summarise some of the more important points that had been brought forward. The first of these was the manufacture of ghee and he intimated that work was proceeding by the Agricultural Department to ascertain whether it would be possible to manufacture this product locally. With regard to the use of concentrated foods he said that it was well recognised that fodder grasses could well be supplemented by the use of concentrated foods such as coconut meal, ground nut meal, rice bran and cotton seed. Experiments in connection with fodder grasses took a long time to achieve results which could be recommended for general practice. He drew attention to an Article in *Agricultural Journal* No. 2 of 1930 dealing with the use of manures for keeping pastures in a constant state of fertility. He remarked that the Government were fully alive to the desirability of placing the dairying industry upon a sound footing and with this object had increased the subsidies payable on imported pedigree stock, grade cows and heifers. It was also proposed to introduce a subsidy on export butter.

*Mr. Speight* moved Motion No. 2 reading as follows:—

> That this Convention appreciates the assistance afforded by Government to the dairying industry of the Colony by the increase and extension of the system of subsidies on pedigree and grade stock and welcomes the proposal to pay a subsidy on butter exported from the Colony.

The above motion was seconded by Mr. A. H. Witherow.

*Mr. Duncan* said that he was unable to support the final clause of Motion No. 2 regarding the subsidy on exported butter. The dairying industry had been going for 10 years and in addition to the direct subsidy had had 4d. per lb in its favour since it started. He proposed that the last clause be eliminated.

*Major Willoughby Tottenham* in seconding the amendment said that the butter industry was likely to become " an old man of the sea " and the industry would never grow up and stand on its own merits if it was pampered too much.

*Mr. McElwaine* said that the high cost of manufacture was due to the small output. The present cost of manufacturing 1 lb of butter and placing it on the market was 7·25d. per lb while the average cost in New Zealand was 2·5d. per lb for a factory manufacturing somewhere in the neighbourhood of 200 tons. The industry in New Zealand and Australia had been established for 70 or 80 years.

*Mr. Barnes* said that New Zealand had been cited on several occasions and it was interesting to note that in 1880 the value of export of butter from New Zealand was £8,350 and that time one might say that New Zealand was in a similar position to Fiji to-day. In the 10 years following the annual export increased to £122,700. The value of butter exported from New Zealand increased rapidily and in 1928 reached £11,960,000. He mentioned points to indicate that an industry of this nature invariably had a small beginning and that the object of the original proposal was to arrange for the payment of some form of subsidy to assist the industry to get on its feet. He suggested that the final phrase of Motion No. 2 be amended by the insertion of the word " welcomes."

*Sir Maynard Hedstrom* said that he did not think it would be possible to find a common ground and that the Motion should be forwarded as an expression of opinion of the dairymen of the Colony.

*Mr. Barnes* said he proposed to do this and Motion No. 2 was therefore withdrawn.

Major Joske read *Mr. E. Duncan's* address on the copra industry as follows:—

I have been asked by the Director of Agriculture to give you an address on the copra industry of Fiji. I fear that the subject is too big for me to do full justice to in the time at my disposal, and I shall therefore merely confine myself to an outline sketch of the industry.

The Fiji Blue Book for 1929 gives the area of nuts in the Colony as 113,564 acres and the export of copra as 28,391 tons. I am under the impression however that the export of copra last year exceeded 33,000 tons, and believe that the area of coconuts in the Colony to-day has reached 150,000 acres. Relative to the area in the Colony which has been reclaimed from jungle, that of coconuts exceeds by far the area of all other cultivated crops combined; and I believe its importance to the Colony generally but especially to the native Fijian, is in direct proportion to its area, though its monetary value does not to my mind place it second in the list of crops, as shown by the mere statistics of the Blue Book. Sugar for instance is grown and concentrated compulsorily in only five districts in the Colony and at most covers 75,000 acres. (Blue Book figures give the area of sugar as 37,000 acres but this is wrong, apparently the areas of sugar land under young plant cane for the following year and in green manure crops having been omitted). Coconuts on the other hand cover 150,000 acres and the location of this growth extends to every inhabited island if the Fiji Group, hence my contention that the copra industry is by far the most important of any in the Colony.

Unfortunately, from various causes and reasons, copra production at the moment is not a paying proposition. Sugar, despite a protective tariff or bounty, at the expense of the consumers in Britain and Canada and to the extent of 50 per cent. of to-day's open market values, as also rubber, are both however in the same unenviable category if that is any consolation. Since restriction of production is out of the question and since we must continue to produce or go under, we must reduce the cost of production if we are to keep our heads above water in the flood of competition which surrounds us. Taxation in steadily increasing ratio to the value of our products cannot be imposed, as it has been for the past 20 years in Fiji, without increasing the costs of living in the first instance, and in the next instance, forcing an accompanying higher all round wages cost of production, and this precisely is what has happened in Fiji in the copra industry, as I shall show later in this paper. Not so long ago the annual budget of Fiji was £450,000 per annum and the population was 150,000, whilst to-day the figures are £650,000 and 165,000 of a population, showing an increase of approximately 50 per cent. in taxation and 10 per cent. in population.

It is in my opinion from these happenings that we are chiefly suffering to-day in our inability to produce profitably in competition in the open markets of the world. We have got " out of step " with costs in most

British Crown Colonies, but especially with those of the Dutch and Philippine Islands producers and are consequently being "trod upon." The actual coloured labour wages cost of producing a ton of copra in Fiji to-day is in the vicinity of £5, as against £2 10s. of 10 or 12 years ago, while to land a ton of copra in Suva, including wages as above, sacks, freights and insurances, European supervision and essential plantation supplies costs approximately £11, as against £7 as recently as about 10 years since. It would be futile besides being undesirable in my opinion had I failed to allude to or attempted to disguise these facts.

Improved methods of production, especially in curing our product by means of economic kiln drying and processing, hold some, though I fear at the moment rather remote, promise of better profits; but unfortunately most improvements cost money and money is a very scarce commodity with copra producers in Fiji to-day. Copra grading and the production of high class copra also come within the category of improvements that can be made in the copra industry of to-day, fortunately at small cost. When starting grading, which must be done under Government auspices and be made compulsory and applicable to all copra shipped from the Colony, difficulties and opposition may be experienced, yet I believe that its value would soon be demonstrated and ultimately grading would be welcomed by all classes of producers of and traders in copra in Fiji.

I do not purpose to go into details on the wages, tasks and such like of our labourers, but may say here that all planters fervently hope that in the revision of the Fiji Labour Laws, which it is generally understood the Government are contemplating, neither the obligations of the planters will be made more onerous or costly nor the liabilities of the employees lessened in any way, than in the existing Ordinances, and that contract or task work will be permitted and governed as at present with clear understanding that "no work, no pay" shall be the rule. Planters feel too that, if they provide food, housing and hospital amenities, they should no longer be called upon to furnish tobacco and clothing or prepay any Government taxes which may be imposed on workers engaged by them.

In conclusion some data may be given which may interest coconut growers: for ordinary trees the spacing should be not less than 30 feet by 30 feet in wet or 28 feet by 28 feet in dry districts. The yield over an estate of several hundred acres fronting the sea and running inland, say, one mile varies between 6 and 7 cwt. dry copra per acre per annum. On any such estate 5,800 to 6,300 nuts make one ton of copra. Usually 52 per cent. dry is obtained from green copra. The cost of producing and landing in Suva of one ton of copra, always provided the coconut areas are kept weeded and decently clean, is not less than £10 per ton, exclusive of interest on capital invested. Coconuts on Taveuni bear well up to 80 years of age, though their maximum yield is probably obtained when they are 20 to 50 years old.

Finally, as to the actual value or cost of the 150,000 acres of coconuts in the Colony to-day, this cannot be set down at less than three millions sterling. That of sugar on the other hand, stands at about one and three-quarter millions sterling, to which it has been written down from possibly three millions sterling several years ago. Then too there are many hundreds of thousands of acres of potential coconut lands scattered throughout the Colony still unplanted, whereas no sufficiently large areas yet remain in the dry districts to which successful sugar production is confined, for the establishment of more than one or two sugar mills. I estimate that at least there are half a million acres of unplanted coconut lands in the Colony, all of which could be brought into cultivation by the natives, or by European planters if the wages and other costs of production were on a parity with those of our chief competitors.

*Major Joske* said that they had listened with great interest to the paper presented by Mr. Duncan, since he was not only the owner of one of the half-dozen biggest estates but also one of the Managing Trustees of the group of estates with the largest production in Fiji. Mr. Duncan's reference to the necessity of reducing costs of production justified the speaker in putting before the Convention three suggestions in this direction which would, he hoped, serve as targets for criticism from those present

*Major Joske* said:—In his address Mr. Duncan has brought his copra from its plantations to its port of export from the Colony. As we are now in Suva, let us imagine it arrived alongside Suva wharf. It is now on its journey to the crusher, and it is the costs incurred on that journey which are of vital interest to the producer in Fiji. I suggest therefore we might examine those costs for a minute. They are—

1. the labour costs involved in taking the copra from the side of the interinsular vessel, weighing it, putting it on a lorry and running it a few yards to a copra store, and finally stacking and storing it;
2. the cost of storing it, *i.e.*, interest paid to the bankers whilst the copra remains idle in Suva, and insurance against the risk of loss by fire, and the shrinkage and depreciation of the copra itself;
3. the labour costs involved in stacking and weighing the copra, carting it across the road and delivering it to the ship's side.

I suggest that it is in (1) and (3) that copra passing through the port of Suva meets with costs that could be eliminated. Mr. Duncan said that we have got out of step with costs in most British Colonies. Plantation labour costs are higher. Therefore, we must make every effort to reduce all other costs to the bare minimum. There is a way in which the Fiji Government can be of practical benefit to the coconut planters and also benefit the other sections of the community. That is by improving the wharf facilities at Suva. Suggestions have been put forward from the Suva Chamber of Commerce; the matter was raised a year ago in the Legislative Council; but so far we have not heard of any progress having been made.

My own view is that the following improvements to the facilities for dealing with copra at Suva should be made as soon as possible—

(*a*) the strengthening of the wharf structure, so that motor lorries can load and discharge copra underneath the steamers' slings;
(*b*) the provision of a waiting shed for copra;
(*c*) a Government weigh-bridge.

As to (*a*), at present lorries are not permitted on the wooden structure of the wharf, which is too weak to bear them. This is indeed a lamentable state of affairs at the prime port of the Colony, and I venture to say there are very few ports in the world which would confess that their main wharf was too weak to stand an ordinary motor lorry. To take an example, at present copra ex "Makatea" in Suva is man-handled four times inwards and five times outwards. If motor lorries could come alongside steamers, it would be practicable to instal a weigh-bridge and the nine man-handling operations of copra could be cut down to four.

As far as (*b*) is concerned, as is well known there are frequent occasions upon which it is impossible for exporters to obtain export storage, on account of inward merchandise. The need for extra storage has already been recognised, but I would urge the extension of the present so-called storage facilities.

There is a space lying idle on that part of the wharf between No. 3 shed and the Harbourmaster's office, and I would very much like to see a shelter shed erected thereon in which storage for up to one week would be afforded to exporters. After all, copra pays an export wharfage of 6d. per ton. The cost of this shed need not be very great, practically a roof set on concrete pillars with weather protection at the side.

As to (*c*), I have suggested a Government weigh-bridge because weights taken under Government supervision would be probably more acceptable to the producer, the exporter and the prospective purchaser overseas. I suggest it really from policy reasons, but I would add that under present conditions, private enterprise would be prepared to instal a weighbridge if Government decided such a thing was to be left for private enterprise. In such a case of course one would not expect Government to reverse its decision and subsequently instal a weigh-bridge in competition. I have sketched the above in outline as this is not the place in which to go into the matter in detail. I put it forward as a practicable suggestion for reducing the costs of the operation of moving the copra from the planter to the crusher.

My second suggestion is to do with the overhead costs of the coconut industry. One of the most important of these costs is that of borrowing the moneys necessary for development. The planters' capital is restricted and the occasional advent of a hurricane depletes the larder. Now that the Colony has a better supply of labour one of the obstacles to the development of coconut areas has been removed. I suggest that the Government should help on this development, and thereby follow the example of many other countries— by making available loans to coconut planters at low rates of interest, repayable over a long term of years. At present the coconut planter would have to pay 7½ per cent. interest to his banker plus probably ½ to 1 per cent. to his guarantor if he desired advances. I suggest that Government might make advances to approved settlers at bare cost, say, 5 per cent. plus the necessary provision for sinking fund, and amortization. The business could quite easily be handled by a Coconut Advances Board of Control on very much the same lines as for example, the Returned Soldiers and Sailors Advances Board. Personally, if I were choosing a Board to-day I should say that a Board composed of the Colonial Secretary as Chairman, the Colonial Treasurer, the Director of Agriculture, Sir Maynard Hedstrom and Mr. Duncan would be hard to better. It may be argued that this time of depression in the price of copra is the wrong time to consider such a proposal; quite the reverse, as it is in times such as these that the planter needs financial assistance in the greatest possible degree.

My suggestion is intended to apply not only to development but to existing mortgages. The price of copra was not always going to remain where it was to-day. I hope although I would not bet on it—to see it back to worth round about £15 a ton at the plantation in perhaps twelve to eighteen months.

I now come to the third suggestion which is one for improving the price obtained for the planter's copra. We had the pleasure of seeing yesterday* a very interesting exhibit put up by the Coconut Committee, and the difference between ordinary native sundried copra and copra which had received some reasonable attention was most marked. I think there can be no doubt that good quality is worth more than inferior, or even medium, and this is probably more especially the case under present circumstances where more and more of our copra is finding its way to the United States. That being the case, we should encourage the United States to look to Fiji for their supplies of good quality copra. There can be no doubt that we have got the goods, but on the other hand, we are not making the most of them. My third suggestion therefore is the separation of good copra from bad copra, and the issue of Government certificates on which the buyer can place the utmost reliance. At present the crusher buys 100 tons f.m.s. copra from Fiji. He may have the luck to have included in the consignment some of the nice white copra we saw on Monday. On the other hand, he may get a dirty weevily article. Being a prudent man, he therefore insures against this possibility in the price, which he pays for his parcel of copra. In other words the good copra is damned for its association with the bad. One might also quote Gresham's Law—that a bad coinage drives out the good.

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* At the Fiji Show.

This matter has been before the Legislative Council as far back as 1927, and a scheme was drawn up which provided for compulsory grading of copra intended to be exported. When the Bill came before the Council it was varied by the substitution of voluntary grading for compulsory grading, and became a dead letter. The view of the Directors of the Coconut Planters' Union is that to succeed at all, grading must be applied to all copra leaving Fiji. We feel too that if Fiji leads the way in establishing certain standards, it may be possible before long to obtain the co-operation of Tonga and Samoa in establishing similar standards. The buyer of copra in San Francisco or in London will then know what he is getting, and it will serve to eliminate the present gamble against securing a good, bad or indifferent delivery against his purchase of South Sea copra.

Everyone will be unanimous on the question of the difference in the quality of plantation copra and ordinary native dried copra, the logical thing would therefore seem to separate these grades. The objections are:—Firstly, the cost of such grading and, secondly, that no increase in price will thereby be received As I am representing the Union established at Suva, it is only proper that I should view the question of costs at Suva alone. Earlier in this paper, I made suggestions for cheapening the handling of copra at Suva, and one of these suggestions involved the erection of a waiting shed for copra. I would propose that this shed should be utilised for the reception of copra at Suva, and that the grading should take place in that shed, or in licensed warehouses owned by responsible exporters, by some suitable officer of the Agricultural Department. An appropriate export mark should be allotted and the copra marked accordingly. The additional cost will therefore be very small, probably only a matter of a few pence per ton, and I submit that the increased revenue to those who sink money, time and care in improving their product will more than justify the results.

As to the second objection that the results will not be commensurate, I imagine this has been an objection to grading of produce ever since the word was first known. Its truth or otherwise in the case of copra can only be proved by experiment over a period of years and since the method I have outlined is one involving no capital outlay, which will not be of great advantage in other ways, I suggest that the objection should not prevent the adoption, at any rate experimentally, of compulsory grading for export.

In summing up the three suggestions I have put before you perhaps I may call them Faith, Hope and Charity. May I say that Faith stands for copra grading and the consequent faith of the crusher of copra in the quality of Fiji copra; Hope for the hope that the Government will improve handling facilities at Suva; and Charity, which begins at home, for the extension of cheap loans to poor planters in these hard times.

*Sir Maynard Hedstrom* in opening the discussion on this paper said he had been asked many times his opinion as to the reason for the long and continued slump in price of copra. From what Mr. Dunçan had said one might gain the impression that the price of copra was influenced largely by the quantity produced but he did not think that that was a factor because the increase in the production of copra had been comparatively small. In 1919 the world's crop was estimated at 785,000 tons and in 1927, 1,135,000 tons. He considered that the factor controlling the price of copra was the production of thousands of tons of Soya bean and ground nuts. In 1920, the production of Soya bean was 719,000 tons and in 1927, 1,958,000 tons. Another factor of importance during the last few years was the production of whale oil. Eight years ago this was 450,000 barrels and in 1928 the production increased to 1,500,000 barrels, while the production for 1929 was estimated at 2,000,000 barrels. The copra producer had his whole investment in his plantation and could not stop making copra just because the price was low, while the growers of linseed, Soya bean or ground nuts could turn their hand to something else if the price was not profitable. Sir Maynard went on to say that with regard to the grading of copra he did not think that any good could be achieved by compulsory Government grading.

*Mr. Taylor* outlined the position with regard to the control of coconut pests, namely, Levuana, Scale and Spathe borer. He said that the work on the first two pests had been brought to a successful issue and the borer work was promising.

*Mr. Surridge* suggested that instead of the square system of planting the equilateral triangular system should be adopted since this adds about 10 per cent. more trees to the acre without any disadvantage. With regard to the question of grading it had been found essential to adopt compulsory grading methods with most agricultural produce, for example, coffee, maize, cocoa, butter and fruit. It was reasonable to assume therefore that methods which have improved the quality and price of such produce should tend to have the same result when applied to copra. Mr. Surridge referred to the rat as a pest of coconuts. He stated that the average damage by this pest to coconut plantations was probably 5 per cent. for the whole of the Colony while on individual plantations it had been estimated after investigation at about 12½ per cent. This was a matter that required urgent attention.

*Mr. Barnes* said that the address and discussion could not but be interesting to any person whether he was directly concerned in the production of copra or not. One of the most important points raised was the general activity directed to the reduction of rats. He said that extermination was perhaps something too much to be hoped for but there was need for active measures on the part of all people in the Colony to suppress these rodents which caused damage amounting to hundreds of thousands of pounds per annum. He said that he was strongly in favour of improving the wharf facilities at Suva which would have for their object a reduction in the costs between the producer and the crusher. With regard to grading of copra Mr. Barnes said that perhaps instead of a system of grading, the producer might be encouraged to turn out a higher quality of product and to endeavour to get more from the same amount of raw material. In an article in the *Agricultural Journal* by the Government Chemist it was shown that 12 per cent. of the copra is lost through insects and mould. This represented almost one eighth of the copra exported and meant a loss of £1 per ton on the present day price at the plantation.

*Major Willoughby Tottenham* moved Motion No. 3 as follows:—

> That in the opinion of this Convention the position of the copra industry gives cause for disquietude and that the possibilities of

securing increased returns to producers should be explored such as by increase of yield, the reduction of production and transport costs and the introduction of a system of Government grading.

*Major Willoughby Tottenham* in speaking to this motion said that the noxious weed problem was serious. The keeping of these weeds down added considerably to the cost of producing copra. He said that Major Joske had urged the provision of more shed accommodation at Suva but he considered that wharf and shed accommodation should be provided at other places in the Colony, for instance at Buca Bay or Taveuni where the copra was produced. If this were done costs would be reduced about 12s. per ton.

*Major Joske* seconded Motion No. 3 which was carried.

### THE BANANA EXPORT INDUSTRY.

After the luncheon adjournment Mr. Barnes reopened the Convention, and addressed the meeting on the banana export industry, which he said was of considerable importance to Fiji, but had unfortunately deteriorated during the past few years mainly owing to the incidence of disease and the irregular and improper methods or lack of methods practised by the Fijian cultivators. The industry had been adversely affected by the hurricane of December, 1929. He remarked that minor amendments had been made to the Regulations and the most important of these was the appointment by the Governor of a Banana Licensing Board which would have power to fix the minimum price to be paid for bananas at packing stations. Indians were very anxious to obtain the same treatment as Fijians with regard to the purchase of bananas and this question was being considered by Government. Mr. Barnes went on to say that considerable uneasiness had been caused amongst banana buyers at the more strict interpretation of the Regulations governing the export of fruit from Suva. He said that reports had been received from merchants and Inspectors in Auckland indicating that there was considerable laxity through the whole industry at this end and that the growers were cutting fruit which was unsuitable for export. It was felt in the interests of the whole industry that that state of affairs should not be permitted to continue and instructions had been issued to the inspecting staff that a much stricter inspection of the fruit was to be made. He remarked that much still remained to be done in connection with the improvement of the general quality of the fruit offered at the packing stations and he felt that all those concerned in this important industry had a long way to go in the work of instructing the native and the Indian grower in the grades and quality of fruit suitable for export. The Department of Agriculture in conjunction with the Native Affairs Department were doing everything they possibly could to teach the Fijian grower. With regard to the packing Mr. Barnes said that he could not help but be struck by the general inferior quality of the cases which were used for Fijian bananas. He considered this one of the weak points of the banana industry to-day. He gave an instance of cases from Sweden and Norway being imported to South Africa at about 1s. ½d. Another important matter affecting the banana industry was the question of transport. He had it on good authority that a large number of cases of bananas could be secured from the Savusavu district if only regular transport arrangements could be made to pick them up. Similarly he felt that there was every prospect of reviving the industry in the Sigatoka district if some regular system of transport could be evolved. He remarked that the banana industry in normal years was worth £200,000 per annum to the Colony of Fiji and at the present time we had only one quarter of that. Mr. Barnes went on to say that recently trepidation had been felt because of the threatened competition from Samoa and Tonga. If Western Samoa could be sure of a regular steamship service with proper provision for fruit, Fiji could be almost entirely cut out of the New Zealand market. He thought that New Zealand preferred Fijian bananas but there was always the possibility that some arrangment might be made to extend the industry in Samoa and get those bananas from Samoa to New Zealand. He said it must be borne in mind that Samoa was a Dependency of New Zealand and though we had a better quality of fruit there was the danger of losing the whole market if we did not improve and keep on improving our standards.

*Mr. Witherow* said that the position of the banana export industry was very poor compared with what it was when the Australian market was open to Fiji. The high rate of freight was a hindrance to the industry. In 1916 the Union Company notified the shippers that it would be necessary to raise the freight from 1s. 9d. to 2s. per case. From then onwards there had been a gradual rise until now the freight is 4s. per case—more than double what it was in 1916. Mr. Witherow intimated that he still considered there were prospects of profitably shipping to Australia.

*Mr. N. MacDonald* said that a subject of this nature could be classified under three headings, shippers, buyers and native growers. He remarked that he did not think some buyers took sufficient interest in the areas allotted to them. He considered that every endeavour should be made to establish demonstration plots in each district where methods of cultivation, selection of plants, and proper planting could be shown. The natives should be instructed in the use of implements.

*Mr. Windham* said that he had been investigating diseases which were causing havoc to the industry. He said the plantations in Fiji were very scattered and this made the work very difficult.

*Mr. J. L. Hunt* said that the present rate of export was about 7,000 cases a month. One person with 1,000 acres of land would be able to export 15,000 cases per month and it would not be as expensive as now. He said he was very pleased to see that the Government had taken in hand the investigation of the diseases of bananas. Little work of this description had been done of recent years.

### CONTROL OF NOXIOUS WEEDS IN FIJI.

*Mr. Barnes* presented a paper on " The Control of Noxious Weeds in Fiji " (*vide Agricultural Journal No.* 3 of 1930).

*Mr. J. L. Hunt* in opening the discussion on The Control of Noxious Weeds in Fiji said that in 1889 there were practically no noxious weeds in Fiji. Now the people of the Colony were right up against things with animal life carrying the seeds of noxious weeds and so increasing their spread. The expense of clearing was very heavy, ranging from £3 to £5 10s. per acre. He was pleased that the Entomologists of the Agricultural Department had been able to introduce the Thrips to assist in the control of Koster's Curse and he considered that the people of the Colony would have to look to the Entomologists of the Agricultural Department to help them in the eradication of other noxious weeds.

*Mr. T. H. C. Taylor* said that the control of noxious weeds by means of insects was one of extreme difficulty and that people expected rather too much in that direction. Although work had been going on for many years on the subject of the prickly pear in Australia it was only lately that any marked progress had been shown. He said that he wanted to emphasise that the greatest care must be taken in introducing insects to control weeds. For instance there were at least twenty different species known to exercise a control on " Koster's Curse " but a lot of investigation was necessary to decide whether or not some of these insects would attack crops of economic importance in the Colony. He thought that it was likely that the biological control of " Koster's Curse " would be a long work and that other insects would have to be imported. He informed the Convention that in the case of Lantana considerable success had been achieved in certain districts, but he must again state that the biological control of noxious weeds was only in the experimental stage and people must not expect rapid results.

*Mr. Barnes* said that efforts had been made to introduce a parasite for Guava and although inquiries had been made in various parts of the world no success had been attained. He said that experiments were being carried out by the Department of Agriculture in the use of various types of sprays including sodium chlorate.

*Mr. E. Duncan* in moving Motion No. 4 as follows:—

> That in the opinion of this Convention a more active campaign directed to the control of noxious weeds in Fiji should be pursued.

said that he hoped eventually we should be successful in controlling " Koster's Curse." He instanced that on Taveuni every ton of copra produced cost 30s. for weeding.

*Mr. A. H. Withcrow* seconded the motion, which was carried.

*Mr. Barnes* said that there was one other subject for discussion, the production and marketing of minor crops and this would be considered at a later date.

*Mr. Barnes* in declaring the Conference closed said that His Excellency had informed him that the Convention could be assured of His Excellency's full sympathy and he hoped the deliberations of the Convention would benefit the Colony. Mr. Barnes said he would like to make a few remarks in connection with the Convention of Associations which was the subject of Motion No. 1. That expression of opinion was backed up by the representatives of the various Agricultural and allied Associations of the Colony and was one that would ultimately be given effect to. It would be necessary to draw up and consider rules and regulations for such a Convention. He considered that each Association should be permitted to nominate a certain number of members to serve on the Convention, the number to be decided by a Committee which would sit to consider this matter. He said the Convention would also encourage and assist the formation of District Agricultural Associations and would permit representation on the main body on terms to be decided upon. He saw no objection to the utilisation of the *Agricultural Jonrnal* as the medium of publication for Convention matters. He suggested that the Committee already appointed should be authorised by the meeting to continue its work and to co-operate with representatives from other associations in Fiji to devise Regulations and to form a Convention of Associations. Speaking on the the other subjects raised during the discussion Mr. Barnes said that quite a lot of important matter had been dealt with. With regard to the Dairying Industry it was a matter of great pleasure to him to hear a discussion on a wider basis than on the occasion of the January Conference. Referring to the Copra Industry he said that the Convention had been able to follow the coconut from the tree to the market and to find out where best it could be helped. He said the Banana Export Industry had come in for its fair share of consideration and certain proposals put before the Convention would receive attention.

The subject of control of noxious weeds was one that was of very wide interest. During his experience in Fiji and from remarks of those he had met, Mr. Barnes said he could well believe what a menace the problem is to agricultural industries and it was the duty of the community to see that the menace was attacked in no uncertain manner. He said the thanks of the Convention were due to the Committee which sat to organise the first meeting. Thanks were also due to the Trustees of the Fiji Museum for placing the room at the disposal of the Convention for the purpose of holding the meeting. In conclusion Mr. Barnes thanked all who had attended and had contributed by reading papers and taking part in the discussions.

*Mr. J. L. Hunt* proposed a vote of thanks to the Chairman which was carried by acclamation.

*Mr. Barnes* then declared the Convention closed.

*Saturday, 12th October,* 1930.

*Mr. Barnes* in opening the discussion on the Production and Marketing of Minor Crops said that the definition of minor crops was a fairly wide one and for the purpose of the discussion could be taken to include all crops apart from sugar, coconuts and bananas, and of course, dairy products. He remarked that there were undoubtedly a large number of crops grown in small areas in different districts either in conjunction with major crops or else as separate little agricultural industries. Some of these found their way by devious channels to the local markets in Suva and other parts of the Colony, but there was no organised system either of production or marketing. He said that he had received inquiries from Sydney in particular and from other places for some of these minor crops which could be grown satistactorily here in sufficient quantity and of sufficiently high quality to command good prices in overseas markets. He remarked that he had been informed by one distributing firm in Sydney that there was an excellent opportunity during June–August to place French Beans on the Sydney market and it was reasonable to expect that one could obtain a price for a properly graded product equivalent to 12s. to 20s. per bushel case. There was also a good demand for the seed in Queensland and New South Wales and he was led to believe that the value of the seed was from 45s. to 60s. per bushel. Mr. Barnes then instanced the water melon which grew well in Fiji and for which a ready market existed in Sydney. Small farmers should be encouraged to grow these minor crops provided that some satisfactory organisation existed for marketing them. He went on to say that that point was one of the most important in the agricultural development of the Colony and with that object in view His Excellency had appointed a Committee to consider the agricultural methods of Fijians and Indians. Mr. Barnes read a letter received from Messrs. A. Q. McGowan regarding minor crops and said that this indicated that ready markets existed for a wide range of products which grew well and produced heavily in Fiji but that apparently growers were not prepared to accept world market prices for their produce. He said that this opened up the question of the need for a sound agricultural educational programme directed not only to the education of the children in the school but to the producers on the land.

### LETTER FROM A. Q. MCGOWAN AND CO.

Dear Sir, Suva, 10th October, 1930.

We have pleasure in handing you the following information relative to experiments and possibilities of business conducted by us covering products which we consider would be profitable to small farmers here.

*Kumalas*, (Canadian Market).—A trial shipment of mixed red and white kumalas to Vancouver were disposed of to Canadian Pacific Mail Steamers realising 18s. per cwt. They were not landed or sold to merchants there for the reason that only white kumalas were in demand. We have not been able to interest any local growers in the export of white kumalas to Canada. A large market is open to us for these during the winter months only—December to April.

*Maize.*—Trial shipment to Vancouver of good quality clean, new maize received favourable comment, and resulted in many inquiries and orders for parcels of 50 tons and up to 200 tons per month. However, the local price was not in keeping with the world's ruling market, which at that time was £9 per ton c.i.g. or about 4s. 6d. per bushel c.i.f. We endeavoured to get maize production going on a large scale, but no grower was interested. We have not since been able to induce any Indian or European to grow maize for export.

*Peanuts.*—Growers in Fiji will not accept the world's market for export and refuse to produce except for local requirements, and at a price to suit their own ideas. We have tried out the possibilities in shelled Fiji peanuts on the New Zealand market, however, we had to meet the Java competition which would not allow us to do business at present values. Fiji shelled small peanuts are worth about £20 per ton c.i.f. Auckland. Java large shelled nuts are worth to-day £25 per ton c.i.f. No large peanuts are at present produced here, the growers stating that they present a little difficulty in harvesting as against the easier grown small nuts. Fiji shelled peanuts are declared to be far sweeter and firmer than the Java varieties sold. Price is the factor. We cannot compete.

*Blackeye Beans.*—These can be produced here cheaply and at competitive prices for export. The difficulty is, however, to supply a clean sample free from weevil. We have not yet secured a clean, dry sample grown by Indians, and have therefore given up the experiment.

*Cow Peas.*—Each year we receive numerous inquiries for quantities, however, the same remarks apply as to Blackeye Beans.

*Rice Beans.*—We also receive inquiries for large quantities, but the same remarks apply.

*Ginger.*—We have successfully established an export market for green ginger during the months of January to June only, and will be exporting during the coming season. Growers receive £18 per ton delivered to our store for prime, clean, well-grown samples only. No inferior quality is exported on any account. We have a big outlet for cargo ginger packed in light syrup in barrels. But this business cannot be tackled until the production reaches some volume. This is worth to-day £60 per ton c.i.f. We are hoping to establish business in cargo ginger within the next 18 months, provided the growers will increase their production sufficiently.

*Pepper.*—We have received inquiries for this but there is no production in Fiji. All our requirements are imported from Singapore, and costing to-day £168 per ton. This is also largely consumed by the Indian population.

*Coriander Seed.*—This does well in Fiji, but growers demand a higher price than the landed cost of imported seed. So that no export business is possible at present. This is worth to-day £15 per ton c.i.f. London for prime quality, market fluctuates violently depending on crops in India and Morocco.

*Pimento.*—A trial shipment to Melbourne realised £28 per ton five years ago, since then the market has been as high as £140 c.i.f. London, and now is £80. We have also tried to interest both Indian and European farmers in pimento, but without result.

*Turmeric.*—Excellent wild turmeric is produced here but is marketed in such poor condition, and so badly prepared, that only small quantities are used. We have asked Fijians and Indians to prepare it properly but they say it means so much extra work for them. Our efforts have been fruitless. Imported turmeric is worth to-day £28 per ton c.i.f. London for best quality.

We shall be pleased to give you any further information relative to above products should you desire it.

Yours faithfully,
A. Q. McGowan,
for A. Q. McGowan & Co.

The Director of Agriculture, Suva.

*Mr. Pearson* said that he would limit his remarks to the question of minor and side line crops for small Indian farmers outside the sugar and plantation areas, produced either for domestic consumption or for sale. It appeared to him that there was a certain lack of enterprise and a good deal of improvident farming going on. In the drier districts of the Colony rice should be considered as the major crop for the Indian although in some districts this was being replaced by cotton. He said that with cotton and rice growers a certain amount of under employment was inevitable unless they had something else to fall back on. Dhal was important as dhal or a pulse of some sort was necessary to the diet of a rice eating people. Two varieties were grown but production was not altogether satisfactory and the crop was subject to the ravages of insect pests. He went on to say that next in importance was maize grown both for supply to the Colonial Sugar Refining Company and very commonly in small patches for home consumption. This crop would be much more widely grown if a ready market could be found for it. He understood that experiments were in hand for the manufacture of maize flour which would certainly be in demand among certain classes of Indians. He also considered that some of the quick growing Indian barleys might succeed well in the Colony and also contribute to the reduction of imported flour and sharps. Other minor crops not to be lost sight of were tobacco, potatoes, ground-nuts, Mauritius beans, and in some areas eating pines. Bananas must be looked on at present as a minor crop from the Indian point of view. Then again there were condiment crops such as coriander, turmeric and mustard and it seemed not impossible that one or two of these condiment crops might be developed into quite an important commercial product, even for export purposes. Mustard oil was another necessity of Indian diet and here again the imported article which was inferior in quality could be replaced. Mr. Pearson went on to say that market gardening was another avenue of activity for the Indians of the Colony. The Indians in Fiji seem to have forgotten what is done by their fellows as market gardeners around the big cities of Northern India. It had been proved by the success of the operations of the Agricultural Department in various Provinces of India that progress was possible. He said that the antiquated idea that if you wanted to grow a crop you had only to procure the seed and put it in without regard to variety or local conditions must be abandoned. He considered that a produce market for Suva was very essential as otherwise the Indian had to hawk his produce around from door to door. An important aspect of the marketing question was the matter of communication and getting the produce to the markets.

*Mr. Grant* said he would like to say a few words about ghee. Even that morning he had tried to buy a bottle of ghee and was willing to pay 3s. to 4s. a bottle for it, but was unable to procure any. The ghee imported into Suva was of very poor quality. He went on to say that mustard seed grows very well in Fiji and instanced one Indian planter who planted up one acre and sold six or seven bags of seed from that area to the Colonial Sugar Refining Company at £2 a bag. He considered that if Fiji could standardise a ghee mixture suitable to the local market there would be a considerable source of income to the producers. Potatoes were imported in large quantities and yet they could be grown very successfully in the Nadroga district. He said there was also the question of sending round men trained in agriculture to teach the Indians how to plant. He was trying to form an Indian Agricultural Association of Planters so that they would be able to co-operate with the other Associations in promoting the welfare of the Colony.

*Mr. Buksh* mentioned peanuts and Beni seed, because they were important so far as the Indians were concerned. Another crop of importance was tapioca. It was one of the staple foods of the Fijians and the Indians were also taking to it. With regard to rice he considered that the varieties we were using in Fiji had become deteriorated owing to the mixture of seeds and he thought this matter should be considered. In India they had two seasons for rice.

*Mr. Fountain* said that he had been living in an Indian district for the last eight months and they were all complaining bitterly about the failure of the rice crop and seemed very keen to grow ginger. He said that he would like some information about coffee as he considered that as a side line crop in Fiji this was an excellent proposition.

*Mr. A. L. Armstrong* said that the Government was very fully alive to the necessity of encouraging the production of crops by Fijians particularly of supplementary crops to those now grown. He said the first thing to do was to educate the Fijians in modern methods of agriculture and the use of implements. He informed the meeting that one Agricultural Instructor was now working in the Sigatoka district, giving practical instruction in the handling of a plough and harrow. This Instructor also assisted the various villages in the marketing of their crops. Mr. Armstrong stated that it was essential to have an assured market for any crops Fijians grew otherwise they became discouraged and it was difficult to interest him in anything further.

*Mr. Surridge* said there were two aspects of minor crops he would like to draw attention to. The first was seed selection and he referred to the specimens of maize exhibited in the Agricultural section of the Show, one specimen grown by Fijians and Indians and the other grown by an European, where the contrast in the quality of that grown by the European was very striking. The other question he continued was one of cultivation. Referring to market gardens worked by Chinese he said it was usual to see the soil cultivated to a depth of 4 inch to 10 inch, whereas in the garden of an European householder one would find the soil cultivated to a depth of 16 in. He remarked that the additional 6 inch or so was very valuable for supplying food to the plant.

*Mr. Barnes* said that the mass of information supplied by the various speakers would be very helpful in assisting and encouraging the agricultural development of the Colony. In closing the discussion he called attention to a few points. With regard to Beni seed or Sim-sim he said that this was grown in large quantities in East Africa and also in West Africa. It should do well in the dry districts of this Colony, and find a ready local market. It was a crop worth while encouraging because it would fit in a system of rotation. He said that he would have liked to have seen a representative of the local oil mill present at the meeting as one of the officers of the Department had discussed with the Manager of the Oil Mill the question of extraction of vegetable oils. He emphasised the desirability of improved systems of cultivation. This subject was one which the Department of Agriculture and the Native and Indian Departments were very much alive to and steps were being taken to give effect to recommendations in regard to instruction in agricultural districts. In conclusion Mr. Barnes thanked those present for attending the meeting and for the interest they had taken in the subject.

## LANTANA POISONING OF CATTLE IN FIJI.

By C. R. Turbet, B.V.Sc., Senior Veterinary Officer.

Since the first recorded case of the disease which we now know to be Lantana poisoning, the disease, in certain locations, and under certain conditions, had become increasingly more prevalent during the past few years, until the incidence of the disease assumed such alarming proportions that considerable consternation was felt among local cattle men. For a time it was thought by them that some new mysterious infectious disease had been introduced into the Colony with imported cattle. Suva butchers were suffering severely, losing a varying percentage of nearly every lot of cattle brought into Suva for slaughter. New animals brought into local dairies were liable to contract it, as were also those newly imported and animals recently brought into the Suva district for the hospital and other dairies and those in transit through Suva.

The disease did not closelv simulate any known acute infectious disease. It showed some resemblance to poisoning caused by the ingestion of certain plants characterised by photo-sensitisation and more closely resembled the text-book description of *Lupinosis*.

*Occurrence.*—The disease occurs in the Suva and lower Rewa disticts of Fiji and less commonly at Tailevu and Navua. It has not been recorded as occurring elsewhere but probably does so under certain conditions. The occurrence of the disease is limited to either young animals bred and reared in the beforementioned districts or animals of any age brought into them. In the former group it would appear that the calves recently weaned and beginning to sample new fodders are liable to contract the disease and slightly older animals tethered or confined within reach of Lantana and on a restricted diet of other vegetation. In the latter group a sequence of events seems to be necessary; subjection to hardship or change of habitat such as occurs when cattle are brought to Suva from some other place either within the Colony or from overseas. In the first case a journey by boat or punt or a long walk overland is necessary, in the second case a long overseas journey. It is assumed that these animals are in most instances, on arrival at Suva, suffering from partial starvation and in all cases have a lowered vitality.

In the Rewa occurring cases[1] the animals affected were heifers. One lot locally bred, nine months to a year old were depastured on the river bank, the other lot, imported heifers about 18 months old, were on an island. In each case Lantana was the chief vegetation. Other plants present were *Solanum torvum*, Guava, *Panicum barbinode*, *Mimosa pudica*, *Paspalum conjugatum*, a species of sedge, wild gooseberry, *Sida rhombifolia* and *Cassia obtusefolia*. The edible plants in each case were scantily present and non-edible plants predominated.

In the Tailevu occurring cases[2] the grazing area was suddenly restricted owing to a flood in the river. It is presumed that this caused the affected animals to sample unusual fodder plants.

*Cause.*—The Lantana plant in Fiji has always been considered to be *Lantana camara* and under that name the cause of the disease was cited in the first published paper[3] by the writer on this subject.

Dr. Seddon, Director of the Veterinary Research Station, Glenfield, New South Wales, stated[4] that his station had not been able to find any evidence of toxic properties in *Lantana camara.* He also mentioned that *Lantana crocea* is undoubtedly very toxic. This communication caused the writer to doubt the identification of the Lantana common in Fiji which had always been taken as fixed. On examination the characters usually ascribed to *L. crocea* were more pronounced than those ascribed to *L. camara* and therefore specimens of the plant were forwarded to Dr. Darnell Smith, Curator of the Botanical Gardens, Sydney, who named them *L. crocea.*

*Description of the Plant.*—Manson Bailey states[5] that "*Lantana crocea* closely resembles *L. camara* but is much shorter and more compact, the heads of the flowers are also the same size and form, but the colours are apt to sport, some producing white, others blue, the normal colour being bright red orange and yellow towards the centre of the head." This description answers that of the Fiji species. It is a compact plant but in competition becomes taller with weaker branches. Along the stems a bronze colouration is noticed in some plants. The flower colours range as follows:—white, white with yellow centre, yellow, mauve in various shades, mauve with a yellow centre, red in various shades, red with yellow centre. No blue flowers have been seen by the writer in Fiji. It is possible that both *L. camara* and *L. crocea* occur in Fiji.

*The Toxic Principle.*—No work has yet been done on this subject by the writer and no reference to it can be found in literature. This remains the subject of further research.

*History of the Disease in Fiji.*—Although the knowledge of the cause of the disease was only definitely ascertained during 1928, the occurrence of the disease we now know to be Lantana poisoning was first recorded[6] in Fiji in 1913. In June, 1913, Lawrence P. Edward, Government Veterinary Officer, reported on the death of a cow at the hospital as follows:—

" This cow was first noticed to be sick about a month previous. It was at once isolated and treated. When visited on June 23rd, she was obviously dying and so I destroyed her. When first noticed she had extensive ulceration of the muzzle and buccal mucous membrane and eyelids, with discharge from the eyes, nose and mouth. She was eating well and the temperature was 103°F. The cause is the necrosis bacillus. The symptoms gradually increased in severity with the addition of necrosis of the skin behind the ears and over the body. *Septicæmia* resulted and caused death. This condition is not very rare in Fiji. It is usually seen in recently imported animals and is very contagious and very fatal. The number of recoveries do not amount to more than three or four per cent."

Edward again reported[6] on the death of a second cow during the same month as follows:—

" The cause of death was septicæmia resulting from extensive necrotic lesions on the mouth, on the muzzle, eyelids and skin caused by the necrosis bacillus. This was a similar case to the one reported earlier in the month. The rest of the cattle are perfectly healthy."

Again in December of the same year Edward reported[6] on the death of a bull at the hospital dairy as follows:—

" I was called in to attend the bull on the 16th December. I found him to be very weak, staggering in his gait, temperature 104°F., constipated, loss of appetite and very emaciated. The integument over the muzzle was dry white and inclined to crack, there was profuse discharge from the eyes (which were very much drawn in) nose and mouth.

" The most noticeable symptom was the skin; this had lost its flexibility and had become hardened. (I can only liken it to " raw hide "). The hair in parts had fallen off. In those parts where there was much movement of the skin it had become folded and from the bottom of the folds a yellow serum was exuding. The bull died on the 19th and a post mortem was made.

" There was a gelatinous exudate under the skin. The liver was enlarged and fatty. The gall bladder was very much engorged and inflamed. It was rather larger than a human head. There was acute inflammation of the abomasum, large and small intestine.

" This is the third case of this kind that has occurred at the dairy. I am now of the opinion that it is caused by some poisonous weed."

Following Edward's report the Chief Medical Officer reported[6] to the Government as follows:—

" It is with great regret that I have to report the death of the newly purchased bull at the hospital dairy. It was quite well on arrival and the Veterinary Surgeon reported well of it . . . . . . earlier in the year we lost two newly imported cows from apparently the same cause . . . . . . the Manager of the Brighton Dairy Company states that he has at times lost cows, especially newly imported ones from a similar cause."

There appears to have been no further record made of the occurrence of the disease from 1913 until the writer's arrival in Fiji in 1923. In that year the writer's attention was first drawn to it in the course of conversation with cattlemen. Later in that year the first cases were observed among some cattle at Waimanu. These cattle had just a week or two previously arrived in those paddocks. Since then the disease has been often observed by the writer and Veterinary Officers of the Department of Agriculture, the outbreaks occurring chiefly in the vicinity of Suva and on the lower Rewa. In 1924 in an endeavour to ascertain the cause of the disease bacteriological tests with material from an animal dead of the disease were made in co-operation with Mr. J. G. C. Campbell, B.Sc., Government Bacteriologist. The results of these tests[7] were negative. Between that time and the end of 1927 feeding experiments were conducted with various plants including Lantana with negative results.[7]

On the 30th December, 1927, feeding experiments were commenced with *Lantana crocea* which ultimately led to the conviction of that plant as the cause of the disease.[3]

Since then, owing to the knowledge of the cause of the disease, cases have become fewer and the tendency to panic on the part of some stock owners has passed.

*Symptoms.*—In from two days to a fortnight after the animal has had access to lantana, the first symptoms are noticed. At first the animal manifests restlessness and loss of appetite. Soon constipation sets in and grinding of the teeth is heard. If the temperature is taken about this time it is found to be elevated to about 103°F. The skin of localized areas becomes very sensitive and later intensely inflamed. This is accompanied by an intense irritation which causes the animal to shake its head and rub its parts particularly the head and ears against fence posts and trees. A mucoid discharge from the nostrils and a lacrymal discharge from the eyes sets in early. There is also dripping of saliva from the mouth.

The parts chiefly affected are the skin of the muzzle and eyelids, the ears and the perineum, udder or scrotum. If the animal has unpigmented areas on the body, the disease will show a preference for these locations and the skin lesions are always more intense on animals with unpigmented areas. These animals, however, are by no means the only animals to be affected with the disease which has been noticed on animals wholly pigmented. In such animals the skin lesions are not so acute but the disease may be just as fatal, the sites invariably affected being the muzzle, the ears and in some cases the coronets and base of the horns.

The inflamed muzzle becomes covered with a brownish yellow serous exudate from the surface. A similar condition is noticed on various parts of the body and the hair becomes matted with dried serum. Two days after the exudation of serum the inflamed areas become devitilized, hard and yellowish-brown. The muzzle is covered by a dry smooth yellowish-brown scab which becomes necrotic and grey in areas where the nasal discharge flows over it. The eyes are sunken and a few days after the onset of the disease the conjuctival mucous membrane is distinctly icteric. The same condition is noticed in other mucous membranes. The discharge from the nostrils and eyes becomes muco-purulent. Abdominal pain is manifested generally by groaning, grinding of teeth and assuming unnatural attitudes. Skin irritation is shown by the animal endeavouring to gain relief by rubbing against solid bodies and one animal was noticed to screw its body in a peculiar manner as though shrinking from pain. Tenderness is particularly manifested on pressure on the right side over the area of the liver and gall bladder.

Urine, golden-brown in colour, is emitted frequently in small quantities. It is rich in bile as is shown by Gmelin's Test.

Constipation persists in most cases. In some, however, diarrhœa sets in later. Appetite is capricious if not altogether lost during the course of the disease. Water is refused. The animal becomes rapidily emaciated and altogether presents a sorry appearance. In a few cases ulcer like erosions occur toward the distal extremity of the tongue and on the dental pad. The breath is fetid and the general odour of the animal is objectionable. Respiration is slow and the pulse feeble.

Death occurs in about 70 per cent. of cases in from twelve to twenty days in uncomplicated cases. Animals surviving that period usually recover.

*Autopsy.*—On post mortem examination there is no discharge from the natural orifices. The body is usually in an emaciated state. The skin lesions are as described under symptoms. In many cases erosions and shallow ulcers are found on the tongue, dental pad and buccal mucous membranes. Oedema and icterus of the subcutaneous tissues is common. An icteric gelatinous exudate is found in the conjunctival sac and in the brisket. An orange yellow serous exudate is generally but not constantly found in the peritoneal cavity. The content of the rumen is small in quantity but normal in appearance. The omasumal contents are unusually dry whilst the remainder of the intestinal tract is practically empty. Small areas of congestion are found in the abomasum and duodenum but they are neither constant nor severe. The icteric condition is general but very prominent along the course of lymphatics and about the hilus of the kidney, joint capsules and inter-muscular septa. The flesh is fevered. The most prominent and constant post mortem finding is always associated with the liver and gall bladder. The liver is always enlarged and friable, varying in colour from yellowish red to ochre-yellow in different animals. Some livers are slightly mottled. The typical gall bladder found in the disease is tremendously distended, containing up to two litres of bile. The wall being stretched to utmost thinness and in some cases bile is found to be weeping through the wall. Organs in contact with the gall bladder are often found stained with bile. The bile is thick and viscid, no definite blockage of the bile duct has ever been discovered in association with the disease.

The bladder is usually found distended with bile stained urine. All other organs of the body remain normal in appearance.

*Pathology.*—It would appear from the nature of the lesions that a toxicological principle is contained in the ingested plant *Lantana croeca*, which acts specifically on the autonomic nervous system in such a manner as to paralyse the heat regulating mechanism of the skin and the peripheral blood vessels particularly in those regions supplied by the fibres of the dorsal cutaneous nerves from the cervical sympathetic, the most constant and early skin lesions being found about the head and ears. The internal lesions are all associated with loss of tone in the plain muscle walls of the affected organs, the gall bladder loses its contractile power. The omasum has no longer power to perform its mill-like function and the contents become dry through absorbtion of fluid from the stationary mass of its contents. The bladder is distended and urine trickles away frequently in small amounts as opposed to the normal large evacuations at greater intervals. Continuous constipation and absence of movement indicate paralysis of the muscle wall of the intestines. All these various functions are controlled by the autonomic nervous system and lesions manifest are such as would be produced by paralysis of that system.

*Treatment.*—As is indicated by the high rate of mortality, treatment is often unsuccessful. The percentage of recoveries is greater, however, among treated animals than untreated ones. The aim in treatment has been in the first instance to remove as much of the toxic ingesta from the alimentary tract as possible. To this end a purgative drench as follows is usually given:—magnesium sulphate 1 pound, powdered ginger one ounce, tinct of nux vomica one ounce, for an adult. Since the animal refuses to drink voluntarily regular drenching with water must be undertaken. Animals which have recovered have been so treated. Chloral Hydrate in half ounce doses well diluted with water might be given to relieve pain but tincture of opium or morphine is contraindicated for this purpose owing to the paralysing effect of that drug on the bowel wall, an opposite effect being desirable. To increase the tone of the latter organ strychnine in one grain doses or tincture of nux vomica in one ounce doses might be given. Dilute hydrochloric acid in doses of two drachms has been given well diluted with water to prevent the absorbtion of toxins. Enemas should be given.

The skin lesions have been treated with a lotion composed of potassium permanganate zinc sulphate and lead acetate, of each two drachms in two pints of water, or an ointment composed of zinc oxide and bismuth subnitrate of each two drachms, lanoline two ounces and lamp black sufficient to make the ointment black.

*Economic Importance.*—The number of cattle actually lost through this disease has not been great and since the cause of the disease is happily now known losses can be avoided. Formerly, however, the position was alarming, local butchers did not feel confident in bringing cattle to the Suva district for slaughter owing to the prospects of the deaths of several. Movements of cattle were retarded and breeders were loath to import cattle or to purchase where it would be necessary to move their cattle through the Suva district enroute to their destination.

*Occurrence in Other Countries.*—Naturally, occurring cases of the disease are recorded in Queensland but the causal plant is recorded as *Lantana camara* and *Lantana sellowiana.*[8] [9] The disease has been produced experimentally at the Veterinary Research Station, Glenfield, New South Wales.[10]

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Owing to delay in receipt of blocks, photographs prepared by the author will be published in a subsequent issue.

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## NOXIOUS WEEDS AND THEIR CONTROL IN FIJI.

By. H. W. SIMMONDS, F.E.S., Government Entomologist.

### PART II—BIOLOGICAL CONTROL.

THE control of weeds, always a serious problem in agriculture, becomes particularly so when those weeds invade grazing lands, or such permanent cultivation as coconuts or rubber, where the return per acre leaves little margin for hand eradication or the use of chemical methods. In such situations weeds of a perennial type are apt to take possession as opposed to the annual types which more frequently occupy ploughed lands. These weeds are usually of foreign origin and are often of quite minor importance in their homes, their success in their new environment being due to their finding some special facility for seed distribution *i.e.* some agency such as doves or mynah birds which feed upon their fruits and scatter their seeds, or an absence of enemies which reduce their seeding power. It will also generally be found that they are distasteful to cattle and thus these animals, by selecting the more desirable growths and avoiding the weeds, favour the spread of the latter.

In such cases it has been felt that the introduction of those agencies which, in its own home land, hold the weed in check, would be the most efficient and economic method of bringing about their control. Such a method has much to commend it, since control, if attained, would be permanent. Still, until recently, it could not be said that very great success had attended the efforts made, from time to time, in this direction. However, the results recently obtained in the control of prickly pear in Australia, by means of a pyralid moth, *Cactoblastis cactorum* aided by two other insects *Dactylopius tomentosus* and *Chelinidia tabulata,* have been most spectacular and give encouragement for further efforts of the same nature.

It must not, however, be thought that such results can in every case be attained. It will often be found that the weed is closely allied to some cultivated crop, when the risk that any agency which attacked the weed would also attack the cultivated crop, would be too great to be taken.

*Seed Destroying Agencies.*—In many cases the most efficient controls will prove to be seed destroying agencies and these do not kill the host plant, which still has to be eradicated by hand. They do, however, reduce its powers of seed production so that, when a piece of land is cleared, it is not immediately resown from adjoining waste areas. Such seed destroying agencies are frequently specific and thus likely to be the safest, as well as the most efficient.

*Noxious Weeds in Fiji.*—The principal noxious weeds of permanent cultivation in Fiji are:—

*Lantana crocea.*
*Clidemia hirta,*
*Stachytarpheta indica.*
*Psidium guayava.*
*Solanum torvum.*
*Micania scandens.*

*Lantana.*—This plant, a native of Central America and now a major noxious weed in many parts of the tropical world, was probably the first plant the control of which was attempted by biological means. In 1902, Koebele visited Mexico and collected a large number of insects which he forwarded to Hawaii for the control of the weed in those islands. Of these introductions, eight were successfully established and undoubtedly by their combined efforts, lantana is very largely checked in its growth and power of spreading. Thanks to the courtesy of the officers of the Hawaiian Sugar Planters' Association certain of these insects have been obtained from Hawaii and introduced into Fiji. The first of these introductions was made about 1912 when Jepson successfully introduced the seed-eating fly *Agromyza lantanae*, Frogg.

Further control seeming desirable, a consignment of the flower eating butterflies *Thecla echion* and *Thecla agra* was obtained in 1921. The former was liberated on Taveuni and the latter at Suva. Only the latter established itself, being now abundant on Vitilevu and Ovalau.

In 1927 the writer visited Honolulu and returned with a large consignment of a leaf sucking Tingid bug, *Teleonemia lantanæ*, Dist. This was probably the most successful of the introductions in this country for, although for a time in doubt owing to the attacks of another bug, *Germalus pacificus*, it has since spread rapidly, passing through the affected areas like fire. It does not, however, kill the plant, except under special circumstances, but for the time being, prevents any attempt at flower and seed formation.

*Clidemia hirta.*—This plant is also a native of Central America, where it has a number of allies. As far back as 1920 inquiries were being made on behalf of this Colony as to the agencies which there held it in control. As a result of these inquiries Urich investigated the plant in Trinidad and discovered a thrips, *Liothrips urichi*, Karny. In 1927 T. H. C. Taylor, who was working on scale parasites in that country, made a preliminary investigation upon the insect and reported favourably, whilst the following year a careful study made by W. Cook, a student at the Imperial College, showed that it was not likely to attack any economic plant.

In 1929 the writer was sent to Trinidad to introduce a colony of the insect into Fiji, which was successfully accomplished. Whilst collecting this colony he discovered a number of previously unsuspected insects, which, by destroying the seeds of the plant, were in that country doing much to prevent its spread. These insects are now being studied by two students of the College, with a view to the possible use of some later, in Fiji.

*Distribution of Colonies of Liothrips in Fiji.*—A strong colony of about 20,000 of this thrips was landed in Fiji in March, 1930. From this liberations were immediately made at Tailevu, Nasinu and Lami. The work of breeding and liberating colonies was then continued by Mr. Taylor, who distributed between 35 and 40 consignments up to the end of August. These were released at Tailevu, Nadarivatu, Sawani, Taveuni, Wainunu, Navua, Ovalau, Sigatoka, Rabi and Savusavu. These consignments were sent out either as colonies of adults or on growing plants in tins, with all stages present. It is still early to give any definite opinion as to what the result of these liberations will be. The insect is small and not easily seen until it reaches considerable numbers. In December, Mr. Taylor found that the Savusavu colonies were well established and spreading, whilst in February, eleven months after their first liberation, the colony at Lami had spread 200 yards, and the Nasinu colony was also established but weak. This is the wet season when normally the insect receives a set back, and judging by the spread of lantana insects it will require at least two, possibly three seasons before any judgment can be made as to its adaptability and powers of increase.

*Stachytarpheta indica* (Blue Rat Tail).—Like the preceding two, this also is a native of Central America, and, when in the West Indies, the writer made a preliminary investigation which gave encouragement that it might be possible to do something to check the spread of this plant biologically. It was found that a certain proportion of the seeds were destroyed, but the agency was not definitely proved. It was probably a *Cecidomyiid*, but, if so, was very heavily parasitised. The elimination of the parasites would of course greatly increase the efficiency of the control.

*Limits of Biological Control.*—Biological control of noxious weeds is only possible where the weed which it is proposed to attempt to control is not nearly related to any cultivated crop. For this reason the use of this method against *Solanum torvum* is out of the question.

As control will usually take the form of reduction of seeding, the plant, if a perennial, will continue to thrive and will still have to be eradicated mechanically. The benefit attained by the control will be the prevention of resowing when once the land is cleared.

Finally, it will probably be found that many of the agencies which help to check the spread of a weed in its own country are too general in their feeding habits to risk introducing into a new country. Nevertheless, sufficient success has now been achieved to justify, in the writer's opinion, further efforts in this direction within the limits mentioned above.

## NOTES OF CONFERENCES ATTENDED IN 1930.

By H. W. Simmonds, F.E.S., Government Entomologist.

I have to report that I visited Great Britain in 1930 in order to attend the Entomological Conference held in London in June of that year as representative of Fiji. I also represented the Colony at the Imperial Fruitgrowers, International Horticultural and International Botanical Conferences held during the same season. Whilst in Great Britain visits were paid to East Malling (2), Rothamsted (2), Cambridge, Long Ashton and Aberystwyth Experimental Stations and Farnham Royal Entomological Laboratory. At East Malling attention was given to the work done on the interrelation between stocks and scions. It had been found that the ordinary commercial stocks were seedlings, genetically impure and, consequently, variable. By the use of stocks obtained vegetatively, uniformity of results was obtainable.

2. It was then observed that different strains, thus propagated, were capable of so far affecting the scion as to vary the date of first fruit production from three to twelve or even fourteen years. The stock also showed effects upon the colouration of the fruit.

3. At Long Ashton further work on the same subject seemed to show that this effect of the stock upon the scion was dependent upon the presence of a portion of the main stem and that, if the graft was made direct upon the root the scion took control and the root then assumed the characters typical of the root system proper to the scion, irrespective of any inherent variation in the types of stock used.

4. At the time of my visiting Rothamsted a demonstration in the use of Adco in the manufacture of artificial stable manure was in progress. It was interesting that the product, which in this case was manufactured from oat and wheat straw, possessed the characteristic smell of the natural article. At this Station virus disease of tomatoes and black spot of cotton were under investigation, the former also being investigated at Cambridge. In the control of these and similar diseases the production of resistant varieties seems the most promising line of research, although where possible this should, of course, be accompanied by the destruction of the insect vectors. It was stated at the Botanical Conference in reference to this subject that " disease resistance was not to be considered as exceptional or infrequent " and a number of instances were given of the methods by which the plant brought about this resistance. It was shown that vascular *Fusarium* wilt of tobacco was, in resistant varieties, controlled by a " corking out " process. Susceptible varieties, when grown under optimum temperature conditions, were often able to overcome the disease by the same methods, although at less favourable temperatures they lacked this power. In wheat and maize susceptibility or resistance to certain diseases was due to the chemical nature of the contained sugars.

5. *Aberystwyth Experimental Station.*—The work at this Station dealt with grasses, oats and clovers and was particularly interesting as showing the improvements which could be effected in these crops by the isolation of pure strains. From typical New Zealand and Danish cocksfoot grasses a large number of very different types had been isolated, many of which would give yields of food or hay, per acre, far in excess of the ordinary commercial seeds. In clovers also similar striking results had been obtained, the variation taking the forms of percentage of leaf, spreading or erect habit, weight per acre, &c. From the same original parents of red clover, types two feet in height were produced and flat dwarfs, not half an inch across.

6. Three visits were paid to Farnham Royal, the recently established entomological centre for the collection, breeding and forwarding of insect parasites from Europe to such other portions of the world as may require them. Arrangements were made with this Institution for the collection and forwarding of a consignment of the fly *Mesembrina meridiana,* the larvæ of which, living in cow droppings, feed upon housefly and other maggots.

## THE CONFERENCES.

7. *The Entomological Conference.*—This Conference occupied from June 17th until the 27th. Many subjects, such as Tsetse fly and locusts, of little interest to this country, came up for discussion and in reporting this and the other Conferences it is only proposed to touch upon those subjects likely to have a local interest.

On the opening day Legislation came under discussion and the necessity for its simplification and standardisation stressed. There was a general feeling in favour of closer co-operation and linking up of Entomological Divisions, especially amongst the African delegates, in order to prevent overlapping and lead to continuity of work. Such problems as the Rhinoceros beetle in Samoa also are a constant menace to the surrounding groups and any method of co-operation which would assist the affected country in overcoming the pest would not only benefit the affected country in question but would minimise the danger to all neighbouring Groups. In discussing the best methods of dealing with pests where native cultivators were the rule, the opinion was expressed that much better results were obtained through the Chiefs where tribal authority was still maintained, than where this had broken down and the cultivator himself had to be treated with direct. Sometimes the production of a resistant stock, such as the nematode resistant coffee in the Congo, or the Jassid resistant cottons were very helpful.

9. A discussion on cultural methods in dealing with insect enemies was opened by Mr. Stockdale. It was shown that some pests could be checked by such means, thus mosquito blight of tea could be overcome by increasing the amount of potash in the sap, on the other hand reduction of shade in cacao often led to an increase of thirps. In the West Indies it was stated that Banana Borer (*Cosmopolites sordidus*) was almost negligible where clean cultivation was practised, on the other hand clean cultivation of sugar in Antiqua gave much greater attacks by *Diatrœa*. Of interest to Fiji was the statement that sheep maggot fly attacks were often a sign of stomach worms.

10. In discussing the biological control of insect pests, methods of breeding parasites *en masse* were demonstrated with lantern slides and details given of work in progress in different parts of the Empire. Of great interest to this country was the subject of the biological control of noxious weeds, the practical utility of such methods having been much doubted until recently. The wonderfully spectacular destruction of Prickly Pear in Australia was, however, very convincing as to the value of insect control where the weed is not closely allied to any cultivated crop. Of interest also to Fiji is the fact that they are also experimenting in that country with a Trypetid fly *Exanstia aequales* for the control of Noogoora burr.

11. *Imperial Fruit Growers International Horticultural and International Botanical Conferences.*—These Conferences followed each other consecutively and, as they overlapped to some extent in the matters dealt with, they will, in this report, be treated as one.

12. From the point of view of this country the most important subject discussed was the citrus industry. The increase in the consumption of this group of fruits in Great Britain was enormous, having risen 50 per cent. between 1914 and 1924, with a further increase to double by 1929. The increase in the consumption of grape fruit was said to be amazing. In addition to Great Britain there were considerable markets for these fruits in Canada and New Zealand. It was felt that whilst there was undoubtedly much planting up taking place in South Aftica, still there was room for considerable expansion within the Empire, especially for grape fruit. It is proposed to summarise and circulate the facts on the subject.

13. Of special interest to Fiji was the fact that for the past three or four years tropical oranges and bananas were being shipped in increasing quantities from Brazil to the United Kingdom. It was stated that there was difficulty in interesting the trade in new fruits, but that a shipment of mangoes from India fetched good prices in London last year.

14. Details were given of the work of the New Zealand Fruit Control Board, which handles the export fruit of that country. This Board had statutory powers and had proved so successful that since it commenced operations in 1925 exports had increased sixfold (?). The Board consists

of four members elected by the growers and two appointed by the Government. They do not attempt to dictate prices, but distribute the fruit as they are guided by results. They also grade it and regulate the shipments, arranging transport and consigning to their local representatives, who distribute to brokers. They are financed by a levy not exceeding three pence per case.

15. I was informed that, in the West Indies, the cost of grape fruit landed on the London market works out at about 14s. to 15s. per case, whilst it fetched from 18s. to 40s. per case, top prices being obtained for late shipments. From that point of view Fijian fruit would come in when prices were high in the Northern Hemisphere. Citrus seeds have been most successfully shipped in an acid sugar culture media, having been first externally sterilised. They are apagamic, containing two to six embryos and, it is inferred that only one shoot will be cross fertilised and that the others will be vegetative and thus of the same genetic composition as the female parent. This means that in raising citrus from seed 50 per cent to 75 per cent. will breed true to the fruit that the seed was taken from, which will account for the continued production of certain types of orange in Tahiti, &c. It was also stated that as far as productivity was concerned plants raised on their own roots had been found to be as good as those on the various grafts. The necessity for obtaining genetically pure strains, both for stocks and scions was stressed by Cheeseman. In certain groups, however, such as monocotyledons, he was of opinion that advance would be best obtained by selecting good types, as the isolation of pure lines would take a long time.

16. It was stated that the variability of cacao seedlings was immense. As showing these differences Freeman quoted the case of eight trees in Trinidad which only averaged three pounds of dry cocoa per annum. These were cut out and replaced by a high yielding strain, when, after an interval of four years, a yield of thirty pounds was obtained. It was added that most estates had twenty to thirty per cent. of non-paying trees.

17. Much interesting information on bud grafting of rubber in Java, was given. The best clones gave five to six times the yield of average seedlings, but they did not in all cases pass this quality on when grafted. Certain clones had, however, been obtained which did so when it had been found that they not only gave a higher yield (2 to 3 times) but also produced a greater area of latex yielding bark, even giving good results at six feet from the ground. As a result of this work the yields in certain areas had been increased threefold and even better results might be anticipated in the future.

18. In another Javanese product, cinchona, it had been found better to use seedlings of high yielding types as a first planting on new land, but when making a second planting grafts on hybrid stocks were more satisfactory.

19. Both at the Conferences and when visiting the Experimental Stations every effort was made to obtain information regarding the interrelation between stocks and scions as it was felt that this might prove of value in citrus work in Fiji. At the Conference figures were produced, showing that in rubber the stock controlled the rate of growth of the scion, but at the same time there was a marked effect of the scion upon the root growth of the stock. The East Malling and Long Ashton experiments of a similar nature have been already mentioned.

20. Many different stocks are in different parts of the world used for citrus, the favourites being sour orange, lemon and shaddock. In some

places, such as Tahiti, oranges are grown on their own roots, as also are mandarins, whilst limes are almost always so grown. It was stated that in the United States of America sour orange gave variable results, probably being less pure genetically than the sour orange used in the West Indies. Dr. Yasami of Japan informed me that in that country two stocks were in common use, one being apparently of the sour orange type and the other being *Citrus trifoliata.* In reply to my inquiry as to the effects of these different stocks, he stated that the former produced a strong growing, disease resting plant, but that the fruit was not so fine in texture as that from the *C. trifoliata* grafts and that it took longer to come into bearing, but was longer lived.

21. Considerable time was given to cold storage problems. With bananas, reduction of oxygen without increase in the C.O. 2 in the atmosphere in the holds was advantageous and there were indications that this line of research might open up new methods of transporting fruit. It was further observed that high potash and phosphoric acid content of soil and fruit were associated with good keeping qualities.

22. Another point of interest was an attempt made to determine the connection between the quantity of mould spores present in a field and the wastage of the fruit of that field in storage. Exposed plates gave a range of from 3 to 700 mould colonies on a given surface and these counts were found to bear a definite relationship to the storage wastage, thus indicating the importance of effectively disposing of all waste fruit in the field.

### GENERAL.

23. *Horticulture.*—Of more general interest were some notes on propagation given by Stewart of Edinburgh. He stated that cuttings started best in an acid soil, such as is produced by a mixture of quartz sand and pumice and that if the litmus test became alkaline a solution of 2 c.c. of glacial acetic acid to 1,000 c.c. of water was used to correct this. He advised against the removal of the leaves which he said should seldom drop off, but added that in spiny plants it was best to remove the spines. Pith was a deterrent to root formation. Oxygen was necessary in the soil water, the addition of hydrogen peroxide to the water when watering sometimes gave great increase to root formation.

24. The presence of much nitrogen in a seed bed was harmful, leading to leaf rather than root formation.

25. It was also stated that, when grafting, the use of wood from older trees for scions generally resulted in earlier flowering.

26. In conclusion I wish to express my appreciation of the opportunity thus afforded of meeting, not only other Entomologists, many of whom I have corresponded with for years, but also a number of Agricultural and Horticultural workers from all parts of the world whose work is very closely associated with Entomology.

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## EXTRACTS FROM QUARTERLY BULLETIN OF THE IMPERIAL BUREAU OF ANIMAL GENETICS.

THE Department of Agriculture maintains correspondence with the Bureau of Animal Genetics through the official correspondent (Senior Veterinary Officer). The Bureau is made use of to obtain the latest information on the breeding of animals, and wherever possible information derived in this Colony which might be considered of use is forwarded to the Bureau. The information is supplied by the Bureau in the form of a Quarterly *Bulletin* and the following extracts are made from issues to date:—

[*Extract from Quarterly Bulletin, No.* 3, *July*, 1930.]

" We would again call attention to the work at the Animal Breeding Research Department which indicates that the genetic factor distinguishing the high milk-yielding cow from her average sisters is probably sex-linked—carried in the X-chromosomes and transmitted, consequently, from dam to daughter and from dam to son to granddaughter, but never through one male to another. After two lengthy statistical studies of the records of over 5,000 cows, Mr. A. D. Buchanan Smith and Miss O. J. Robinson are now able to say definitely that the existence of this factor in the Aryshire breed can be considered as established. There is also confirmatory evidence from other breeds."

*Sterility.*—The other main cattle-raising problem which comes within the province of this Bureau and which especially afflicts the owners of improved breeds, is undoubtedly the problem of sterility. That this character has sometimes a genetic basis—particularly when the result of prolonged inbreeding* is beyond doubt; but it seems more frequently to be the result of obscure physiological processes, and therefore lies evenly upon the line which divides our work from that of the Bureau of Animal Nutrition (excluding, of course, sterility that is demonstrably due to pathological conditions). The physiology and bio-chemistry of reproduction in mammals are now being intensively studied at the Animal Breeding Research Department; and it is hoped that before very long sufficient of the rationale of the whole process may become clear enough for us to put definitive data before our correspondents. Meanwhile, they may be interested in a recent brief study of Mr. A. D. Buchanan Smith.

It was first noted that the feeding of sprouted oats to poultry in order to promote rapid growth in the young stock also induced fecundity and high egg production. Next, in America, it was argued that modern methods of husbandry deprived cattle of the flush of young grass during the breeding season, and that this might be a cause of sterility. It was decided to try the feeding of sprouted oats to eleven animals which were sterile but showed no abnormality in the genital organs. After treatment all of them proved to be in calf. In addition, seven heifers were fed sprouted oats before being bred; four conceived at the first service, the others required two, three and four services respectively. The treatment was also effective with six cows and ten heifers. It has not been decided what is the optimum stage of growth at which the oats may be fed. Oats which have barely sprouted and those which have sprouted 2½ to 3 inches have proved effective.

The equivalent of 5 ℔ of dry oats, *i.e.*, 13–15 ℔ of sprouted oats, is fed, and conception occurs after a feeding period averaging approximately sixty days. At Beltsville oats have taken the place of an equivalent of silage in the ration.

It is doubtful whether the treatment has any effect upon heifers with cystic ovaries or other abnormalities.

A pedigreed Ayrshire bull, which seemed to be sterile, was sent to the Animal Breeding Research Department and given the sprouted oats treatment. At the end of five months he was proved to be fertile; and there are indications that the treatment has been successful with male goats and one boar (Essex). It is not possible, however, definitely to attribute the fertility of the bull to sprouted oats, since his might be only a case of delayed maturity.

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* A. D. Buchanan Smith, " Inbreeding in Cattle and Horses," *Eugenics Review*, October, 1926.

It is, of course, well known that vitamin starvation, certainly of vitamin E, will cause complete sterility in mammals and probably in other orders of the animal kingdom. But the foregoing suggests that there is a further vitamin, perhaps essential only to cattle, which is necessary for the proper functioning of the gonads. Obviously the matter is still in the hypothetical state; and further evidence, practical or scientific, would be of great assistance to most of our correspondents.

Turning now to the problems more peculiar to the tropical and sub-tropical Colonies, we would call the attention of correspondents to a recent publication of the Philippine Islands Bureau of Agriculture, *How to Build up and Improve a Herd or Flock**, which contains many facts and suggestions of great use to the Government Officer who must care for different types of stock, and at the same time cut his coat according to his cloth. The author touches upon that crucial problem of the sub-tropics—the acclimatization of " improved " breeds to unusual conditions; for if this were possible it would render largely unnecessary the prolonged work of hybridisation or of pure selection.

He writes:—" For many years horses, mules, and cattle have been imported into the Philippine Islands from the States, Australia and China, principally . . . . .

" As a general rule all the horses and mules that were fed imported feed common to their native land have fared as well from a physical standpoint and have given as long, if not longer, general average service than if they had been in their native countries and employed in the same kind of work as in the islands.

" If for some reason, through change of ownership, or otherwise, these animals are fed exclusively on locally grown feeds, containing no grain like palay or corn, they invariably go from bad to worse and within a comparatively short time become complete physical wrecks, though they may have been in splendid physical condition at the start.

" Native ponies, if fed on imported feed for several years, and in splendid physical condition, will, if turned out on local grass, actually starve to death and that within a comparatively short time . . . . . .

" Cattle of the highly improved breeds that have been imported for breeding purposes and have been kept up, or stabled, and fed suitable feeds, have also done well. Nearly all of those that were turned out to subsist exclusively on local pastures have quickly become pitiful looking physical wrecks and, sooner or later, died of malnutrition or some inter-current affection largely attributable to the poor physical condition. . . . . ."

It might at first appear as if we were here trespassing into the field of animal nutrition; but it is impossible to consider the genetics of a beast without regard to environment; and it does indeed seem possible that the inherent unsuitability of the improved breeds in exotic conditions may frequently be only a genetic incapacity to thrive on inadequate or unaccustomed food. It is questionable whether the development of good dairy or beef types even from indigenous breeds would be possible without a corresponding improvement in their feeding and husbandry; and it might therefore be worth the while of animal husbandmen, after some small-scale experimentation, to consider whether they could co-operate with the Agricultural Departments in growing such feed as would enable their improved stock, imported or native, to thrive.

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* Kretzer, David C., " How to Build up and Improve a Herd or Flock," *Bulletin* No. 43, Bureau of Agriculture, Manila.

## SELECTING IMPROVED DAIRY SIRES.

*Widespread Failure.*—To the dairy breeder the selection of the herd sire is a most difficult problem. Recent research has shown that type can give very little indication of economic dairy characteristics. At any one time the number of bulls in a breed which are likely to create a real and positive advance is very limited; 10 per cent. of all the bulls in use would probably be a high estimate. Further, since the qualities of a herd sire in a dairy breed can only be gauged after the daughters of that sire have been raised to maturity, many, indeed, the majority, have gone to the butcher before any estimate can be made of their value to the breed as a whole.

At Mount Hope Farm, Williamstown, Massachusetts, Mr. E. Parmalee Prentice realises these things and believes that the only way to select a dairy bull is on the performance of the bull's daughters. Mr. Prentice has a herd of Guernsey cattle and he does not believe that selection by appearance and pedigree will lead to any improvement whatsoever. In fact, he goes so far as to say that the average dairy cattle, pedigreed or unpedigreed, of any country is no better than it was, fifty, a hundred, or a thousand years ago. He says that he could pick up as good high yielding cows in Poland as he could from amongst the Advanced Registry herds of the United States. Mr. Prentice does not make this statement rashly. He refers to many scientific experiments where, by mating merely on type and pedigree, no real or permanent improvement has been achieved. Particularly he refers to the experiment on poultry of Professor Gowell at the Maine Station, which was begun in 1897 and completed in 1907. Professor Gowell aimed at establishing a flock of hens of high average production by the apparently logical and obvious method of mating high record hens to sons of high record hens. After ten generations of breeding it was found that the average production of the flock was no better than at the beginning. Nevertheless, as Mr. Prentice says, the Gowell System of breeding is continued in many places throughout the country and, as regards cattle breeding especially, it is the method followed by the large majority of breeders.

*Success of the Progeny Test.*—Great beginnings have frequently led to great disappointments, and Mr. Prentice quotes a prominent poultry breeder as saying, " There is no man living to-day who has a two hundred-egg strain, and there never in the world has been developed a flock of birds that in quantities would average anywhere nearly two hundred eggs year after year." By his methods Mr. Prentice has proved the falsity of the statement. By selecting cockerels from high-producing strains and only using them in the flock after their value was known by means of the progeny test, Mr. Prentice has been able to develop a two hundred-egg strain in a flock of some 700 birds—a truly remarkable achievement. But he has been able to increase on this, and maintains a steady yearly improvement of about seven eggs more per bird per year. Now his average stands at about 213 eggs per bird in a 700 bird flock.

Mr. Prentice is applying the same principles to his Guernsey herd. Unfortunately, the bulls with the best genetical constitution do not always have the best daughters, for it may happen that these bulls were mated to cows of less than average production and that their offspring were so little above the average of the breed that they attracted no great attention, while high records might be made by daughters of ordinary bulls which had been mated to females of high inheritance. These good bulls might be unnoticed, while bulls of less breeding worth are not amongst the well known sires of the breed. To avoid this difficulty, with the assistance of Dr. Goodale an index of the sires breeding ability has been evolved and is employed as the basis of breeding operations at Mount Hope.

*An Index of Production.*—The " Mount Hope Index " is as follows:— " Compute the average mature equivalent of the milk production of all daughters of the bull; also the average mature equivalent of the milk production of the dams of these daughters, and take the difference between these averages. If the daughters' averages exceed the dams' average, add three-sevenths (or ·4286) of the difference to the daughters' average to get the bull's milk index figure. If the daughters' average is less than the dams' average, substract seven-thirds (or 2·333) of the difference from the daughters' average to get the bull's milk index figure."

" The index for percentage of butter fat is obtained in a similar manner, but with different fractions. If the daughters' butter fat average percentage exceeds the dams' butter fat average percentage add three-halves (or 1·5) of the difference to the daughters' average to get the bull's butter fat index. If the daughter's average is less that the dams' average subtract two-thirds (or ·6667) of the difference from the daughters' average to get the bull's index. Multiply the milk index by the index figure for percent of butter fat."

Concerning this index Mr. Prentice states:—" The method of appraising the breeding value of a bull by these index figures has the great advantage that it separates the two factors of milk quantity and butter fat percentage and gives the breeder a definite idea of the bull's influence on each of these important matters. Of course, like mortality tables and all other indices based on averages, the figures which come out to decimal points can rarely be numerically exact in any particular case. Being based, however, on the actual performance of the individual bull under consideration, the figures will approximate the truth, becoming more accurate as the number of dam-daughter pairs on which averages are based increases.

" The operation of the rule is such that as we pass to low levels of production, differences between dams' and daughters' averages becomes less and less, finally reaching zero at the point of minimum production for the breed. Here the sire's breeding index equals dams' and daughters' average production. But there are other differences, non-genetic in nature arising from variations in the health of the animals or from environmental conditions, particularly differences in feed and care, which, magnified by the arithmetical processes used in calculating the index, become obstacles both to genetic research and progress in practical breeding.

" Of course it is impossible, by this or any other existing rule, to foretell the future value of individual untested animals. The rule does, however, enable us to employ a correct method in selecting animals for the test, and gives an intelligible reading of the results of the test when made."

*The Index for Females.*—" The rule is applicable to females as well as to males, and therefore, in selecting animals for the test, choice would naturally be made of those which come from parents both of which have high indices. A bull, one only of whose parents has a high index, is, so far as concerns production, a sort of half-breed, and nevertheless not at all to be disregarded where so many pure-breds are less than this. Some young bulls can be found, however, which are not half-breeds, but which come from parents both of which have high index figures. It is upon these bulls that the hope of the breed depends. Other bulls may well be tested, and many of half-breed origin will rank high, but the best chances come with the bulls from highest ranking parents.

" A young bull chosen for the test by this method, if given light service during his second year, may before he is six years old have three or four tested daughters and a number more on test, so that while he is yet young it is possible to reach a good estimate of his worth as a breeder. A rule which accomplishes such a result as this, is of the utmost value to the entire dairy industry, for it gives to painstaking breeders a method by which they can take their work out of the realm of speculation and make it a matter of system and orderly progress. For those who follow this practice, not only is the tragedy of slaughtering a good bull impossible, as also those other tragedies of keeping animals whose names will occur to many breeders in well-known barns, to the permanent injury of famous herds, but also—what is more important—the means are at hand by which bulls which will raise the production can be recognised."

Where production can be measured the Mount Hope method is fundamentally sound, as is the basal principle. There are other methods of measuring the progeny test than that employed by Mr. Prentice, and this point is at present under investigation at the Animal Breeding Research Department. It yet remains to be seen whether or not the Mount Hope Index is the best way of measuring the progeny test. It certainly is by no means the worst. In any case, Mr. Prentice, by his vigorous advocacy of the progeny test, is doing a service to all who would improve dairy cattle. We might add that Mr. Prentice's work has attracted the attention of many foreign Governments, and we would wish him every success in it.—A.D.B.S.

*Milk and Draught.*—The views that it is possible to combine these qualities in the same strain of cattle receives further support in a recent letter from Fiji (Senior Veterinary Officer), Department of Agriculture, Suva, where there is a preponderance of the Australian milking shorthorn breed. " This breed, of course, is famed for its milk production, while the steers grow to such a large size in this country that they are difficult to better as draught animals. . . . . . they have also been crossed with zebu cattle, and the resulting cross provides the working bullock par excellence. Cows of this cross are also fair milkers and are good mothers. . . . . . "

[*Extract from Quarterly Bulletin, No. 2, March,* 1930.]

### MASS HERD IMPROVEMENT.

An interesting experiment in mass herd improvement is reported from Western Australia. The Director of Agriculture (Perth) writes:—

" Probably the most outstanding factor in regard to " Mass Herd Improvement " is covered by the establishment of the Zone System for the utilisation of pure-bred " above-standard-production " bulls in grading up the ordinary herds in the zones or districts, one breed of bull only being used in each zone with the view of providing a continuity of policy in the grading up of the common cattle.

" Although this policy is not compulsory in the cases of private individuals, it is pleasing to be able to report that it is being closely followed and is growing in importance as time proceeds, in addition to which the Government had distributed 400 standard-bred dairy sires, all of which are out of officially tested dams with production above standard and distributed strictly in accordance with the Zone System.

" The allocation of the zones was decided upon after a series of conferences with the breeders, the Council of the Royal Agricultural Society, and officers of the Department of Agriculture, the scheme being initiated by the Department of Agriculture.

" The operation of the " Dairy Cattle Improvement Act " resulted in the improvement of the class of dairy sires in use, as follows:—

" In 1923 there were 177 pure-bred bulls, of which 75 were the progeny of cows that had been officially tested, with production above standard. In 1928 the number of pure-bred bulls was 714, of which 587 are the progeny of officially tested cows, with production above standard.

" Undesirable scrub bulls destroyed or desexed during the period number 1,240."

### INDIAN CATTLE.

An authority on Indian cattle has challenged the statement in the last *Bulletin* that the average yearly milk-yield of the Sahiwal herd at Ferozepore " approximates to 9,000 ℔ or more per cow," which was a quotation from one equally well versed in the subject. It is probable that that figure only refers to exceptional cows, and that the average of the herd is not much above 5,000 ℔.

Some further comments on the last *Bulletin* come from Dr. D. Clouston. He writes that the Indian breeds of cattle are much more resistant than the European to contagious abortion—" Some of our veterinarians in India attribute the prevalence of contagious abortion on the military dairy farms to the introduction of exotic blood (mainly Ayrshire and Holstein) into the herds."

He also mentions that the Indian cattle of the plains, but not the hill cattle of the Himalayas, are decidedly more resistant to rinderpest than are European cattle, and require a less massive innoculation. On piroplasmosis his comment is: " Indian cattle are remarkably tolerant to the germ of this disease. It is in their blood, but the germ does not appear to become active until and unless the host gets run down in condition after an attack of rinderpest or as a result of starvation."

### A GENERAL PURPOSE HORSE.

A general-purpose horse of an unusually good type has been achieved in Canada by selection of the French-Canadian horses. These horses first appeared in Canada when Louis XIV of France sent out a few of his best specimens to the new Canadian colony. Little attention seems to have been paid to them at first, which was, perhaps, all to the good, since natural selection in that cold climate with bad winter roads did its work in eliminating all except those of very high vitality and endurance. Then in 1912 the Experimental Station at Cap Rouge started selecting these French-Canadians and breeding up a stock. They have been quite deliberately bred—mainly by inbreeding—for general purposes, and the resulting horses are reported to be useful and attractive animals. Usually black in colour, rather like a large Welsh cob, they are said to look and trot well in a trap or even carriage, and, at the same time, when put to heavy labour seem able to outwork bigger and heavier team-mates of other breeds. They are described as docile and kindly animals that put their hearts into their work, and can even endure a Canadian winter in open-fronted, single-boarded sheds without suffering. Apparently too, they are not limited to a cold climate, since a team was sent out with the Royal Canadian Artillery to South Africa for the Boer War, and returned unaffected by the climate.—EXPERIMENTAL STATION, CAP ROUGE, QUEBEC, CANADA.

### EPILOGUE.

It is the desire of the Bureau to build up a picture gallery of the livestock of the Empire, since a good photograph is of more value than any description in indicating the type and points of a beast under consideration. Moreover, the Bureau is now engaged in preparing the material for a monograph on the phylogeny of the domestic animals, and is also co-operating with the Bureaux of Animal Health and Animal Nutrition in a rapid survey of the live-stock of the Empire and their commercial potentialities. We should therefore be very grateful to any correspondents who would send us photographs of their animals, particularly of the indigenous types and first and later crosses, and so enable us to be of more assistance when consulted.

## PINEAPPLE CANNING

By D. H. GRIST, Agricultural Economist, British Malaya.

FACTORY methods for canning pineapples vary considerably between Malaya and the other countries of production, notably Hawaii. In the latter country, machinery is used as much as possible, whereas in Malaya, owing to its relative cheapness, hand labour is employed for almost all the operations. It is a curious fact that while in Hawaii the cans are purchased from a central can-making factory, in Malaya each factory is equipped with a complete can-making machinery.

A further marked difference between these two countries is that in Malaya the factories are generally established in close proximity to the pineapple plantations. The most distant are the five factories in Singapore, which draw the bulk of their supplies of fruit from Johore—a matter of perhaps 30–50 miles by road. The nearest to the centres of production are in Johore where there are twelve factories, situated so close to the fields that transport is reduced to a minimum. The principal factories in Hawaii and Africa may be situated a considerable distance from the plantations. The nearest plantation to the largest Hawaiian factory is twenty-five miles distant. The Port Elizabeth factory is 125 miles from the estate, the latter being intersected by over 150 miles of roads.

The fact that by the Malayan method, transport both of fruit and empty cans is reduced to a minimum, has its advantages. The fruit can be harvested in a riper condition than would otherwise be possible, while the factory methods are such that generous use is made of labour—which is comparatively cheap; while freight—which is comparatively expensive, is reduced to a minimum.

The question of power must also be considered in connection with situation and size of factory. In Hawaii, electricity is used at a cost of from 2–4 cents (gold) per kilowat. In Malaya, the power required for a factory of 1,000–1,500 cases per day can be supplied by an engine of 15–20 h.p.

### CAPACITY OF FACTORY.

Factories in Hawaii are capable of turning out 1,500 cases per day; one factory is said to have a capacity of 4,000 cases a day. The largest output by a factory at Port Elizabeth, South Africa, is stated to be 2,300 cases per day. From a consideration of the number of factories working, the methods employed, and the total quantity of canned pineapples exported, it is evident that the average capacity of a Malayan factory is lower than that of Hawaii or Port Elizabeth. Probably from 1,000 to 1,500 cases per day is the utmost limit of our local factories, while the capacity of the majority is even less.

### COST OF FACTORY.

According to an Hawaiian authority, the cost of machinery, (excluding the cost of the buildings) capable of producing 1,500 cases per day, would be the equivalent of about $90,000 (Straits Currency). An important pineapple packer in Malaya published a statement in 1927 that "about $150,000 capital is necessary for an ordinary pineapple factory and for a factory of bigger capacity $300,000 will have to be invested." These figures, obviously, include working capital. The machinery in a Malayan factory with a capacity of 1,000 cases a day may be between $13,000 and $20,000 excluding shafting, power and cost of building.

The following details of factory methods refer to Hawaii and South Africa. The Malayan methods are so different, that they will be stated subsequently.

### CAN-MAKING.

Hawaiian canners do not manufacture their own cans, but purchase them at $28 (gold) per 1,000 from a can-making factory. A similar system is employed in Formosa, where the areas under the crop are somewhat scattered.* The Port Elizabeth factory manufactures its own cans with a plant capable of producing 30,000 to 35,000 cans daily.

A machine cuts the tin-plate to the requisite size for the body of the can. Flanges are then cut at each end of the body section to make the hooks or edges which will interlock to form the two side seams. It is then rolled to a cylinderical shape, double seamed, interlocked and automatically soldered. The bottoms and tops are cut out and shaped by a press, the bottom being then fixed on a by seaming machine. Rubber solution (in Malaya, a thin band of rubber, locally manufactured) is applied in a groove on the outer edge of each disc; this renders the use of solder unnecessary and ensures that the cans are airtight.

### PEELING, CORING AND SIZING.

The "Ginaca" machine automatically performs the operations of peeling, coring and sizing. It is made in three sizes; Viz., No. 2½, No. 2, No. 1. It has the disadvantage that it will only prepare fruit of one size diameter and cannot be adjusted to fruits of different sizes. The 2½ "Ginaca" will handle about 38 pines per minute. It is made by the Hawaiian Pineapple Company and costs $5,900 (Gold).

In the operation, the pines climb a chain conveyor and are placed in position. The machine then cuts off the skin in two pieces, cuts off the top and bottom, extracts the fruit still adhering to the skin, then cores the pine.

The fruit is then conveyed to a trimming table, where any irregularities are rectified by hand.

A slicer is then employed, also made by the Hawaiian Pineapple Company, costing $2,000 (Gold), which cuts the fruit into slices about half an inch thick.

### CANNING.

The fruit is graded as it proceeds along a conveyor. The usual method is for certain of the workers to be responsible for picking out the best for "fancy" quality, others being responsible for standard quality—the remainder being broken pieces.

The broken pieces are conveyed to vats where they are broken up and boiled, becoming crushed or grated and packed in cans for special markets.

Cans containing slices are taken to a vacuum machine, costing $1,800 (gold), which removes most of the air, and thence to the Syrupping Machine

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* The pineapple canning industry in Formosa is relatively small, but is rapidly increasing.

($1,100 gold) which fills them with sugar syrup and thence to the Exhaust Box, a steam chamber, where they remain for six minutes at a temperature of 210°F.

The Double Seamer ($2,500 gold) places the lid in position, bends the edges down and under, after which a second machine flattens them hard in this position.

The cans are then sterilised for seven minutes at a temperature of about 222°F., and placed in a Lacquer Bath ($250) which improves the appearance of the can and is said also to retain the can in an airtight condition.

Subsequently the cans of fruit are dried and stored until labels are affixed.

### SYRUPING.

The syrup with which the cans are filled is prepared with cane sugar and water, pineapple juice not being employed in its preparation. O'Conner, reporting on the South African product states:—" Different syrups are used according to the variety of grade of fruit canned. As the ' Giant ' or ' Cayenne ' pineapple is less sweet than the ' Queen ' variety, more sugar is used in preparing the syrup in which it is preserved."

The following is the percentage of sugar used:—

For Queen Pines, 1st Grade fruit 27 per cent sugar
For Queen Pines, 2nd Grade fruit 16 per cent. Sugar.
For Cayenne, 1st Grade fruit 40 per cent. sugar
For Cayenne, 2nd Grade fruit 30 per cent. sugar

Under the Canadian regulations affecting the importation of canned pineapples, the following are laid down respecting syrup:—

> " Heavy Syrup " for pineapple will be considered as that syrup which cuts out not less than 23 per cent. Balling at 60°F.
>
> " Light Syrup " for pineapples will be considered as that syrup which cuts out not less than 17 per cent. Balling at 60°F.

### MALAYAN FACTORY METHODS.

The operation of peeling and cutting or slicing are always performed by hand. Grading is performed by the worker during these operations.

The following machinery is usually employed in a Malayan pineapple canning factory.

*Foot Shears*, for cutting the tin-plate into strips. Cost varies from $300 to $500 (Straits Currency). Two such machines are necessary in a factory having a capacity of 1,000 cases per day. Each machine can be worked by one man.

*Roller Shears*, for cutting the body strips for 1½ lb flat size. The machine will cut six strips at a time. One such machine required: cost about $1,000.

A locally made hand machine, costing about $25 each is employed for rolling the body pieces. From five to ten machines of this description are used in a factory.

The edges of the body pieces are then notched by hand with a pair of scissors.

*Soldering.*—Lap-soldering of the body pieces in cylindrical form is performed by hand. The usual contract price for this work is 11 cents per 48 cans.

*Automatic Bordering Machine*, prepares top and bottom edges for double seaming Two such machines, costing about $500 each, each with a capacity of 3,000–4,000 cans per hour are used Each machine can be worked by one man

*Punching Press,* for cutting tops and bottoms; three or four such machines employed at a cost of about $900 each The dyes of different sizes for these presses are locally made and cost from $100–$200 each according to size.

*Double Seamers.*—For seaming bottoms to body. Cost $700 each. Two machines of this description are used for the bottoms, and another two for the lids. Capacity, about 1,500 per hour for each machine.

### GRADES.

Malayan pineapples are packed in three grades, viz:—Special Golden, Good Average Quality (G.A.Q) and Number 3. No. 2, now less frequently prepared, finds a market in China. The popular description is cube, although slices and whole pines are prepared for special markets. Several descriptions of shapes of tin and weights of content are marketed, although the tendency recently has been to reduce the number. A case of pineapples may contain 48 cans of 1½ ℔ each, a case of 2 ℔ cans may contain 24 or 36 cans according to whether the packing is of whole pines or slices, while the packing of 2½ ℔ cans invariably has 24 cans to a case.

In Hawaii, the "sliced" is packed in two grades, "fancy" and "Standard" and apart from "Crushed and Grated" and one or two Special packings, only round cut sliced is made.

### BY-PRODUCTS.

Only about one-third by weight of the pineapples received in the factory is utilised. In Malaya, no use is made of the waste from the factory. Greenstreet and Gunn Lay Teik* shew that for the economic disposal of the waste, the removal of the juice is essential. They describe remunerative methods of disposal of the partially dried waste, and also shew that the fermentation and distillation of the fresh juice for the production of a potable alcoholic liquor similar to brandy is a simple process. As far as the present writer is aware, no factory in Malaya has commercialised these results.

### COST OF CANNING.

It is stated that canned pineapples can be produced in Hawaii at £20 per ton delivered to the consumer, the factory cost being about $1·50 (gold) per dozen cans.

The African costs are said to be £5 per ton for fruit, and £5 per ton for cost of manufacture.

In 1927, a Malayan pineapple packer published the following statement of the factory costs per case of 72 ℔:—

| | |
|---|---|
| 16 sheets of tin plate . .. .. .. | $1·65 |
| Lead and soldering .. .. .. .. | 0·10 |
| Good White Sugar .. .. .. .. | 0·80 |
| One empty wooden case .. .. .. | 0·50 |
| Labour .. .. .. .. .. | 0·40 |
| Water and fire wood . .. .. .. | 0·20 |
| Rubber stripping .. .. .. .. | 0·10 |
| General expense of the factory .. .. | 0·75 |

a total of $4·50 per case of 72 ℔ to which must be added the cost of the pines (80 medium quality pines per case, costing from 1–2 cents each).

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* "By-Products of the Pineapple Canning Industry" by V. R. Greenstreet and Gunn Lay Teik.—*Malayan Agricultural Journal,* Vol. XVI, No. 1, January, 1928.

The total cost per ton on this computation would be $186 or approximately £22 ton. In view of the fact that the price of canned pineapples in Singapore is below this figure, it must be supposed that packers have been able to reduce their costs of production. In any case, the above statements of costs in different countries must be taken, at best, as only a rough approximation.

In conclusion, the writer has tried to shew that the Malayan pineapple canner has endeavoured to establish a market for a cheap but good quality product. This has been made possible by the following means; employing cheap labour, treating pineapples as a catch crop, placing the factories near centres of production, and producing a less elaborate and unlacquered can. The market now established, the quality of the product has been improved, and there would appear scope for further extension of the industry.

In the preparation of the above article, the writer is indebted for considerable assistance from the following sources: Notes on the Pineapple Industry in Hawaii, from a private source; The Pineapple Industry in South Africa from a Report by Mr. C. A. O'Conner of the Mauritius Department of Agriculture; Mr. P. T. B. Hansen of Singapore; The Empire Marketing Board Reports; and data collected from time to time by various officers of the Department of Agriculture, S.S. & F.M.S.

## COCONUTS.

*British Malaya.*—The following particulars are taken from a report of progress in relation to coconut research up to June 30, 1930, furnished by the Department of Agriculture.

*Ceylon Coconuts.*—The Agriculturist visited nine estates in the North-West Province of Ceylon for the purpose of investigating the various methods employed in the cultivation of coconuts and the preparation of copra. The results are embodied in a report which has been published in the *Malayan Agricultural Journal* (1930, 18, 378) and the chief points therein may be summarised as follows:—

1. There are approximately 1,000,000 acres planted with coconuts in Ceylon.

2. The annual rainfall in the areas visited ranges from a minimum of 45 in. to a maximum of 103 in. per annum (Malayan limits 40 to 230 in.).

3. The soils range from light sand to very light clay (lighter than Malayan coconut soils).

4. The estates generally vary in size from 400 acres to 1,000 acres.

5. Planting is between 60 and 70 palms per acre, but this is considered too close, particularly on estates which practise a regular system of manuring.

6. The average age of palms varies between 35 and 45 years (Malayan Estate: 20 years (av.); Native: 30 years (av.)).

7. Clean weeding is not practised and most of the estates are under light grass which is kept grazed by cattle.

8. On a number of estates grass is being replaced by low-growing, leguminous cover plants and *Dolichos Hosei* is generally employed for this purpose.

9. The general practice is to plough to a depth of 6 or 8 in. and then harrow with a disc harrow alternate rows every two years.

10. It is generally recognised that more satisfactory returns can be obtained by the application of artificial manures. The composition of the manures employed varies considerably, but as a rule 8 ℔ of a complete mixture is applied in alternate rows annually.

11. Harvesting takes place at two-monthly intervals and an average of two bunches per palm is collected at each picking.

12. The heaviest pickings occur during the wettest months, May and July, when the yield is over twice that of the smallest monthly yield.

13. For the nine estates visited the average yield of nuts per palm is 66 and the yield per acre averages 3,940 nuts. (The yield of nuts per palm for estates under Malayan conditions is approximately 50, with an average yield of 2,200 nuts per acre).

14. Only ripe nuts are harvested. The nuts are stored in heaps of from 3,000 to 4,000 in the field for about 4 weeks in dry weather and for 5 weeks in wet weather. Husking is done in the field and transport is by bullock cart or light railway.

15. Kiln drying is the general practice and the system is to dry in the sun for one day on a cement barbecue. The nuts are then placed on the kiln in a layer 12 in. to 18 in. deep and turned daily. After 2 days the shells are removed and drying is completed after 2 or 3 more days—making 5 to 6 days in all. (Malaya 1½ to 4 days.)

16. Special precautions are taken to prevent mould growth in the store-shed, where sorting into three grades of quality is carried out.

17. The average yield of copra for the nine estates was 14 piculs per acre (Malayan estates average 9 piculs per acre).

Arrangements have been made with six estates in Ceylon to supply selected seed nuts from five of their highest yielding palms with a view to establishing small experimental plots in Malaya. Of the first lot of seed nuts, some 300 have been sent to the Experimental Plantation, Serdang, for germination, while the remainder have been examined in the Chemical Division. The full report is not yet available, but the following figures may be quoted:—

| | Two Malayan estates. | Nine Ceylon estates. |
|---|---|---|
| Average weight of wet meat .. | 475 grms. | 405 grms. |
| Average oil content (dry basis) .. | 65·6 per cent. | 67 per cent. |
| | (Av. of 60 croppings from different trees.) | (Av. of 35 nuts from from 30 trees.) |

Small experimental plots will later be established with these Ceylon nuts on six selected estates in different parts of Malaya, and when the palms eventually come into bearing a chemical examination will again be made of the nuts so produced under various Malayan conditions.

*Copra Research.*—The following is a résumé of the work of the Assistant Chemist for Copra Research.

*The Structure of the Wet Meat in the Nut.*—Considerable variations exist in the oil and moisture content of different pieces of wet meat taken from a single nut, particularly if the nut is not ripe. Furthermore, any one piece of wet meat is itself far from uniform in structure.

(*a*) *Oil Gradient.*—Nuts which have not quite begun to germinate may show an oil percentage of about 35–40 per cent. (dry basis) and a moisture content between 75 and 80 per cent. on the inside face of the wet meat, whereas immediately under the testa or brown skin the oil content will be in the neighbourhood of 70 per cent. to 75 per cent. (dry basis) while the moisture may lie between 20 per cent. and 50 per cent. A more unripe nut will show a still steeper oil gradient, but, on the other hand, as the nut ripens and begins to germinate the moisture percentage becomes less and the oil content becomes practically uniform at between 68 and 75 per cent. (dry basis) throughout all the layers of wet meat.

These facts have an important bearing on (1) the methods of sampling for purposes of analysis and comparison of individual nuts, (2) the best time for picking to give the highest oil and copra yields per nut, (3) the means to be adopted to dry the copra so as to obtain a white, uniformly well dried, brittle product.

(*b*) *Structure and Ripeness.*—A long series of comprehensive observations are being made of the physical and chemical characteristics and the structure of under-ripe and over-ripe and just-ripe nuts obtained from high, medium and low-yielding palms.

The results so obtained will provide important information as to the changes occurring in the ripening nut, and, more important still for practical purposes, will indicate definitely what problems have to be faced in drying and the methods which should be adopted to obtain the whitest and most oily copra in the quickest way possible.

It has already been found that:—

1. While the ripe nuts from certain trees regularly show a uniform oil content in the neighbourhood of 63 per cent. others give ripe nuts containing 71 per cent. of oil (dry basis).
2. The ripe nuts from one tree were found to require 189 nuts to produce a picul while another required 360 nuts.
3. When one takes into consideration the average annual yield (for nine years) the following average annual equivalent yields are obtained from the selected palms when ripe nuts are picked.

| Palm. | Av. oil content of copra (dry basis). *per cent.* | Av. nut yield per annum. | Av. No. of ripe nuts per picul. | Equivalent copra yield per acre. (*piculs*). |
|---|---|---|---|---|
| 1 | 67 | 106 | 260 | 20 |
| 2 | 71 | 107 | 225 | 23 |
| 3 | 71 | 67 | 360 | 9 |
| 4 | 63 | 67 | 280 | 12 |
| 5 | 65 | 27 | 290 | 4·5 |
| 6 | 68 | 16 | 270 | 3·0 |
| 7 | 69 | 104 | 250 | 21 |
| 8 | 67 | 87 | 180 | 24 |

1 picul = 133⅓ lb

(*c*) *Ripeness, Oil and Copra Yield.*—Concurrently experiments are being performed on other estates in which the problem is being approached from another point of view. The whole crop from a given area is being divided into picked and fallen nuts, all rotten nuts being rejected. These nuts are then being split and divided into five groups according to the absence or size of the embryo. The number of nuts in each group is counted, and the wet meat is then converted into copra and weighed and finally analysed for oil content and judged for appearance.

On the first estate selected, of over 1,000 nuts examined from a mature area producing 11 piculs to the acre, 486 nuts had fallen naturally, while 498 were picked; in addition 50 ripe unsprouted, picked nuts were taken from an adjoining area and were stored for one month. About 70 per cent. of the nuts were collected in a satisfactory condition of ripeness, whilst the remainder were only slightly more over-ripe or under-ripe. In the circumstances striking differences of copra yield and oil percentage were not brought out. The smallest number of nuts required to produce a picul of copra was shown by fallen nuts with pea-sized to ¾ in. embryo, viz., 188 nuts, the largest number of nuts was required by the just not ripe fallen nuts which required 218 nuts to make a picul of copra. The 50 picked ripe nuts after being kept for one month required proportionally 227 nuts to make a picul of copra. The average yield for the whole area showed that 200 nuts were required to make a picul of copra. When one remembers that Malayan estate pickings average 250 nuts to the picul whilst native pickings take up to 350 nuts to the picul, one is able to appreciate the excellence of the nut collection in this estate.

(*d*) *Physiology of Growing Nut.*—Experiments are about to start on the weekly comprehensive examination of dated nuts so that the rate of development of wet meat, copra and oil can be studied while the nuts are ripening (*i.e.*, from 200 days old to 500 days old.)

*Provisional Conclusions.*—It will appear that the best time of picking in order to produce a good uniform type of copra will be when the oil percentage of the wet meat is highest and most uniform, when the moisture conditions are lowest and most uniform and, irrespective of any slight corrosion near the embryo, when the greatest weight of dry meat is obtainable from the nut. It is believed that these conditions are satisfied when a haustorium about 1 in. in diameter is to be found in the plucked nut. Thus only ripe, fully brown nuts should be picked. On the other hand, large quantities of nuts are being picked in this country in a state of extreme under-ripeness, and as a result the copra produced from the very wet meat contained therein is thin, wrinkled, low in oil, and irregularly dry and therefore prone to mould growth and deterioration. Two such nuts will only produce the same weight of such inferior copra as of good oily copra produced from one fully ripe brown nut, and will take longer to dry.

*Driers.*—Some consideration has been given to the product obtained from a number of different driers, but the more complete examination of the working of each individual drier will be deferred to a later date. The present indications are that drying in Malaya has been speeded up at the expense of the quality of the product as regards oil content, uniformity and amount of contained moisture, and colour. Extra heat applied at the wrong time and with insufficient air movement has resulted in a case-hardened product, with a wet centre, an apparent loss of oil, insufficient and/or irregular drying, caramelisation and in some cases actual burning.

It has been noticed that the drier meat from the more ripe nuts is more prone to yellowing and caramelisation during drying than is the wetter meat from unripe nuts. This fact will have to be borne in mind and the drying conditions will need to be designed so as to overcome this trouble.

In order to work out and develop a standard process to produce perfect copra it is necessary to start with, as far as possible, a uniform raw material. If any unripe or over-ripe nuts are removed and dried separately, the bulk of ripe, brown nuts can be dried under the conditions calculated to produce a uniform and white product of maximum dryness in the shortest time possible.

*Types of Copra.*—An interesting series of sorted types of copra was exhibited at the Kuala Lumpur Show. The oil content of each type of copra was calculated and an approximate idea of the thickness of the copra was determined. The results show that careful preparation and nut collection is rewarded by a higher oil and copra yield.

It can also be observed that a high oil percentage (dry basis) may indicate either that the copra has been derived from over-germinated nuts, or, on the other hand, that considerable deterioration has occurred.

| Type of copra. | f.f.a. | Oil per cent. (d.b.). | Oil per cent. (w.b.). | Average thickness | Relative yield per nut estimated. | |
|---|---|---|---|---|---|---|
| | per cent. | per cent. | per cent. | mms. | Oil. | Copra. |
| Good F.M.S. .. .. .. .. | ·06 | 65·6 | 61·9 | 9·0 | 100 | 100 |
| Wrinkled from unripe nuts .. | ·63 | 60·0 | 55·2 | 5·0 | 51 | 56 |
| Thin from over-ripe nuts . .. | 3·01 | 74·2 | 70·7 | 4·5 | 60 | 52 |
| Burnt and carbonised .. .. | ·34 | 64·9 | 60·3 | 8·5 | 94 | 96 |
| Caramelised and slight insect attack .. .. .. .. .. | ·24 | 64·8 | 61·5 | 8·5 | 96 | 96 |
| Burnt and heavy insect attack .. | 1·50 | 60·1 | 56·9 | 7·0 | 74 | 80 |
| Slimy, black and rancid .. .. | 5·01 | 73·7 | 68·8 | 7·5 | 80 | 72 |
| Heavily black moulded .. .. | 5·25 | 68·3 | 64·3 | 8·5 | 92 | 88 |

Good quality F.M.S. copra may show a somewhat low oil percentage (dry basis) from certain trees and areas, but a very low oil percentage is generally indicative that the nuts have been picked young or that the copra has been burnt and/or heavily attacked by insects.

*Storage of Copra.*—The high oil content shown by mouldy copra after prolonged storage is due to the removal of the inner layers of low oil content by the moulds, the remainder showing a slowly increasing oil percentage as a result. During shipment and handling in storage a heavily moulded copra may dry out when the mould will fall away as dust, leaving the copra clean, frequently still internally white and rich in oil. Furthermore, if inferior copra which has developed, a high degree of rancidity and mould growth is stored under good conditions, the acidity is actually able to diminish while the copra as a whole will become dry and cleaned up.

Six large samples have been stored for three months in airy conditions and the two extreme examples are as follows:—

*Copra from Muar.*—Light brown, mouldy and slightly attacked by insects—

| | *per cent.* |
|---|---|
| Original acidity .. .. .. .. .. .. | ·72 |
| Final acidity . .. .. .. .. .. .. | ·42 |

*Copra from Kelantan.*—Dark brown, very mouldy and insect ridden—

| | *per cent.* |
|---|---|
| Original acidity .. .. .. .. .. .. | 3·12 |
| Final acidity . .. .. .. .. .. .. | ·80 |

All the samples showed a more or less proportional reduction in acidity and finished up dry and mould free.

The explanation of this is to be found in the drying out of the copra. Further acid formation is arrested while the acidity already existing is gradually converted into water vapour and gas. It must be appreciated that during deterioration coconut oil is turned into free acid with considerable heat development and that the free acid so formed is lost with further heat development.

*Financial Losses in Storage.*—The full extent of the losses sustained by the producer when his copra is piled as a huge stack in an ill-ventilated storehouse, in order to dry out the copra preparatory to weighing, has yet to be determined. Very considerable heat formation and darkening, mould growth and acid formation are found, with the result that a loss in weight due to oil loss occurs and a higher percentage of copra is classified as F.M. owing to deterioration of the good pieces of F.M.S. quality down to trade

F.M. The remedy for this state of affairs really lies with the producer, because if he completely dried his copra it would not deteriorate in storage nor would it need to be stored before acceptance. Furthermore, because of the time and trouble saved to the shipper, he could offer a better price for guaranteed dry copra.

*Insect Attack.*—Another matter which is receiving attention in the department is insect attack during storage resulting in very considerable losses in copra weight and total oil.

A number of samples of copra have been received from world-wide sources, but owing to detention in transit, the time since despatch has been considerable, with the result that extremely heavy insect attack has resulted. The material has not yet been analysed, but from its appearance, the immense amount of fibrous dust present and the method of attack, it is obvious that the insects have consumed the oil and rejected the fibrous material. The copra is in many cases a mere shell, buried in brown dust; the rich oily copra immediately under the testa has almost in every case been completely removed and attack has taken the form of tunnelling from the soft inner surface of the meat straight towards that oily meat under the testa.

When burnt, " caramelised " and white copra are found side by side, the two former are attacked first, and for a while the white copra remains unattacked. It will be remembered that in the cropping experiment the most ripe nuts produced a caramelised yellow product which was rich in oil. The oily nature of this copra may be the reason for the preferential attack, or alternatively the more pleasant flavour of slightly burnt copra may be the cause.

Existing stores should periodically be cleaned and sprayed with disinfectant, the copra should be piled only in a dry state, and the production of " case-hardened," hastily prepared copra with a hard skin and a soft wet centre should be avoided. It would be better, however, if stores were built with windows and doors constructed of iron gauze so that when clean dry copra is put in, free ventilation is possible, but the ingress of insects is prevented.

## EMPIRE FRUIT SUPPLIES, 1930.

THE following extract has been taken from the *Weekly Fruit Intelligence,* issued by the Empire Marketing Board, dated 7th January, 1931:—

The year 1930 has in many ways been a notable year for Empire fruit on the British and continental markets so far, at any rate, as the volume of supply is concerned. In the early part of the year, shipments of grapes, peaches and plums from South Africa established new records, and the total for all deciduous fruits throughout the season was little short of 2,500,000 packages, an increase of 900,000 over the preceding season and of 500,000 over the previous record in 1928–29. At the same time Canada was shipping apples from a Nova Scotian crop gathered in the autumn of 1929 exceeding all previous figures, and exports of barrel apples to Europe, for the first time for many years, exceeded the corresponding shipments from the United States, while the close of the Jaffa orange season in May showed total exports of 2,700,000 boxes, or 700,000 more than the previous record in 1926–27.

During the summer months Australia and New Zealand shipped respectively 4,320,000 and 1,100,000 boxes of apples to Europe, the bulk of them to the United Kingdom; in each case these were larger totals than had ever been recorded previously, while, at the same time, shipments of pears from these two Dominions also reached record proportions. Throughout the summer also, the large South African orange crop was being marketed almost entirely in this country, and reached the formidable total of 1,840,000 boxes, or 740,000 more than had ever previously been shipped overseas in one season, while South African grapefruit exports, exceeding 100,000 boxes, were not much short of double the largest exports hitherto recorded. Towards the end of the year the new Canadian apple crop began to reach Europe in even larger quantities than at the beginning of the preceding season; the 1930 British Columbian crop was the heaviest in history, and although the Nova Scotian and Ontario crops were relatively light, they have moved across the Atlantic in large volume, total shipments from Canada to Europe from the 1930 crop up to the end of the year aggregating some 3,700,000 boxes (including barrels in terms of boxes), as against 2,900,000 at the same time a year ago.

Finally, shipments of bananas from Jamaica during 1930 reached new heights, exceeding the 22,000,000 bunches exported in 1928, and although the United States is the chief market for Jamaica bananas, imports into this country also established a new high record.

## FIJI LIVESTOCK RECORD ASSOCIATION.

### MEETING OF BOARD OF DIRECTORS, 7TH OCTOBER, 1930.

*Present.*—Director of Agriculture (Chairman), Messrs. G. Kiss, J. Barber and C. R. Turbet.

1. The minutes of the previous meeting were read and confirmed.

2. Mr. Kiss raised the question of opening a calf register. After discussion it was decided that Mr. Turbet should prepare rules for such a register.

3. Owing to the shortage of veterinary staff it was decided that Rule 47, which provides for the branding of stock with the Association's brand, should not be enforced in the meantime, and that stock should be registered without bearing such brand.

4. It was decided to hold the Annual General Meeting of the Association on the date of the " Tofua's " sailing in January, 1931.

5. It was decided to print the herd-book prior to the Show to be held in October, 1931. The Board was of the opinion that stock entered for competition as pure-bred should be required to be registered in the Association's herd-book.

## ERRATA.

IN the list of noxious weeds to be found in Vol. 3, No. 3, p. 112, certain botanical names were spelt incorrectly. Thanks are due to Mr. W. Greenwood of the Colonial Sugar Refining Company Limited, Lautoka, first for supplying the names, and secondly for drawing attention to the inaccuracies.

Since the publication of the above *Journal*, the Burr (unnamed) on the same page has been identified by Dr. Darnall Smith as *Urena lobata*, var. *scabriuscula*.

| *Errata.* | *Corrigenda.* |
|---|---|
| *Acacia farnesiana* | *Acacia farnesiana*, Willd. |
| *Stachytarpeta indica* | *Stachytarpheta indica.* |
| *Cenchus echinatus* | *Cenchrus echinatus.* |
| *Eleophantis scaber* | *Elephantopus scaber.* |

# AGRICULTURAL JOURNAL

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## EDITORIAL.

### CITRUS EXPORTS.

ATTENTION has been paid to the possibilities of increasing the citrus export industry and thus securing higher returns to producers. Oranges and mandarins have figured amongst the minor exports from Fiji for many years, but no proper attention seems to have been paid to the conduct of the business, either by the grower or the shipper. The increasing competition which Fiji has to meet in the New Zealand markets from other Islands of the South Seas should of itself provide a sufficient incentive to those engaged in the fruit export industry of Fiji to take every possible step to see that their fruit is of the highest quality and that it reaches the market in sound and attractive condition. Results of investigations made during the past season are recorded in this issue. They indicate a very real need for the adoption of improved methods of picking, handling and packing of citrus fruit for export and show clearly that increased returns will be obtained by the exercise of proper care at all stages. It does not appear to be generally realised in Fiji that fruit of this nature should be handled as carefully as eggs and that bruises and other forms of skin damage result in fruit rots which completely spoil the fruit for marketing. The methods normally used here result in a very high degree of wastage which causes heavy losses to all concerned, To maintain and develop this important side-line it is essential that standard methods be adopted without delay.

Since the article in this number was written, information has been received from Mr. A. L. Armstrong in regard to one case of mandarins which was sent to him through the firm of Messrs. Turners & Growers Ltd., Auckland. Owing to various causes the fruit was not delivered for a period of five weeks after its arrival and during this time it was lept in cool storage. On opening the case the contents were found to be in excellent condition and only three out of a total of 100 were uneatable. The remainder were of a uniform golden colour and quite firm. The fruit was juicy, not shrunken, and generally quite sweet, although a few were slightly acid. This interesting record emphasises the excellent carrying and keeping qualities of Fiji mandarins when they are handled and packed in a proper manner.

### COPRA.

Copra prices continue to be low, although signs of improvement in the market are evident. The necessity for reducing production costs and improving the quality of the product by the practice of better methods of preparation is more evident during times such as these than, perhaps, when the demand for copra is good and prices high. In an article published in this number an endeavour has been made to outline the history of attempts to introduce copra grading in Fiji and to urge the desirability of the early introduction of such a system. It is desired to place on record a note of appreciation of the valuable help and advice received from the Imperial Institute, London, and from the London Copra Association, as well as for the keen and active interest taken in this subject by the Coconut Planters' Union Ltd. of Fiji.

### RAT CONTROL.

Investigations into this important problem have been continued and correspondence with the Imperial Institute, London, is now published for the information of those interested. The peculiar nature of the greatest difficulty attendant upon any scheme for rat control in coconut plantations in Fiji—the habit of the rodents which in many instances live permanently in the trees—makes a satisfactory solution much more difficult. It is clear that no reliance can be placed on viruses, which are indeed definitely condemned by many authorities; not only because of their limited success, but of the danger to the health of man. It appears that rats are the cause of considerable damage in pineapple plantations. In such cases the use of baits containing red squill powder should be found effective. In addition to the use of thin zinc sheets nailed round the trunk of the trees, the possibility of employing a band of tanglefoot mixture in a similar manner has been suggested as a possible control in coconut plantations. Observers, however, state that in some parts of the Colony the rats rarely, if ever, descend from the trees. In one instance where a coconut tree was cut down, no less than 80 rats, which endeavoured to escape from the crown, were killed. It seems clear, therefore, that in addition to other methods some means of laying poison baits in the crown will have to be found. The question continues to receive close attention.

### AGRICULTURAL CONFERENCE.

It has been decided to hold an Agricultural Conference again during Show Week in Suva. By the courtesy of the Municipal Council the Town Hall has been made available for this purpose. It is proposed to open the proceedings at 2.15 p.m. on Tuesday, 13th October, 1931, when it is hoped that His Excellency the Governor will preside and address the Conference. The Organising Committee has decided that the following subjects will be dealt with at the Conference:—" The Citrus Export Industry "; " Production and Marketing of Supplementary Crops "; " The Stock Industry with reference to the Export of Chilled Beef "; " Some Problems of the Banana Industry "; and " The Pineapple Industry." Gentlemen prominently connected with these aspects of agriculture have been asked to deliver addresses, after which the subjects will be open for general discussion. Notices giving full details of the Conference arrangements will be published in the local press.

The Committee formed for the purpose of organising an Agricultural Convention has continued its inquiries and approved of draft rules for submission to the first meeting which it is hoped to hold during Show Week in conjunction with the Conference. The proposals are briefly, that the Convention should be a central body representative of the various Agricultural and allied Associations in the Colony, each of which would appoint two members to the Convention. The object is to provide a central authoritative body which can advise Government on agricultural matters raised by the various participating Associations and, generally to help the development of agriculture in the country districts of the Colony. The various Progress and other Associations in Fiji are being communicated with and it is hoped that they will all approve of the formation of this Convention and agree to become participating bodies.

## CITRUS EXPORTS—EXPERIMENTAL SHIPMENTS.

By A. C. Barnes, Director of Agriculture.

The citrus industry of Fiji is worthy of more careful attention on the part of both growers and exporters than it has hitherto received. Though there are no citrus plantations of any note in the Colony there are numerous blocks each of a few trees which yield excellent fruit, and which, if cared for, would become a profitable source of income to owners. At least one person recognises the possibility of establishing a plantation of trees of selected varieties of oranges and grapefruit. In the Sigatoka district a small area has already been planted and gives promise of returning a profit to the owner.

2. Citrus fruits, that is to say, oranges and mandarins, have long formed an important section of the minor produce exports of the Colony, but the business has been badly organised, and carried on with almost an entire neglect of the most elementary precautions necessary to ensure that the fruit reaches the market in a saleable condition. That any market at all exists indicates that the fruit is of good flavour and of inherent qualities which commend it to the consumer.

3. The markets available to Fiji are good. The fruit can be exported at a time when Californian, Australian, Tahitian and Norfolk Island oranges are unobtainable. With the exercise of care during all the stages of harvesting and preparation for the market, the fruit of Fiji can command a pre-eminent position in the market of New Zealand during April and May, and in Vancouver during May, June and July.

4. It is, perhaps, unfortunate that the need for attention to this valuable asset should have come to the fore at a time of difficulty which has faced the major industries of the Colony. Unfortunate in so far that the very difficulty of low market prices may deter many from giving the attention to a commodity which has hitherto been regarded purely as a side-line, almost but not quite unworthy of serious attention.

5. Nothing beyond the most cursory examination is necessary to point out the faults of present methods of handling the citrus crop. The fruit is dashed from the trees, thrown into boxes and transported to Suva, where much to the annoyance of the exporter it has to undergo a quarantine of seven days in fly-proof storage, after which it is examined, culled and "packed" under Government supervision. Though the rejection of fruit showing signs of fruit-fly is ruthless, the packing is in most instances nothing more than throwing the fruit into banana cases, and nailing down the lids. The amusement of those in other countries who regard the citrus export business seriously and who take every precaution to ensure that their fruit reaches the market in prime condition can be imagined!

6. From the moment the fruit leaves the tree in Fiji to the time it reaches the consumer it is exposed to every possible form of mal-treatment and the wonder is that any reaches the market in eatable condition. As it is, the losses are heavy and the financial returns far lower than the industry should command.

7. The existence of a small plantation of Mediterranean varieties of orange and of mandarins at Nasinu made it possible to secure sufficient supplies of fruit under control conditions to make experimental shipments to New Zealand during the season which has just closed. The area in question had been neglected for some nine years and late in 1929 the dense undergrowth was cleared, the land cultivated and the trees pruned of superabundant growth. A small crop was obtained in 1930 but it was not until this year that the trees attained anything approaching normal bearing.

As it was the fruit during its early stages of development suffered from the strong winds and storms of November, 1930, and February–March, 1931. The trees survived the severe buffeting in a wonderful manner and most of the fruit was of excellent quality.

8. Although it can hardly be claimed that standard modern methods were adopted for the harvesting and handling of the fruit, every care was taken to ensure that the minimum of damage occurred from the time of removal from the tree until it reached the consuming market. The fruit was cut with a portion of the stalk attached and a second cut was given after the removal from the tree so that the stalk did not protrude beyond the button. Harvesting took place during dry weather and commenced about the middle of the morning when the surface of the fruit was free from surplus moisture. The oranges were loosely packed in banana cases and immediately transported to Suva by lorry. The danger of bruising during transport was reduced as far as possible by placing the boxes on a thick layer of grass and the driver was instructed to proceed slowly over rough. portions of the road.

9. On arrival at Suva the cases were stacked clear of the floor and with ample ventilation space between them in a small well-ventilated concrete insectary where they underwent seven days' quarantine required by New Zealand regulations. During a portion of this time they were treated with ethylene gas in order to stimulate the development of the orange colour of the skin and so to enhance the appearance of the fruit. The method adopted was to introduce a charge of the gas giving a concentration of approximately one part in two thousand, the room being completely closed. After a period of four hours the room was ventilated by means of fans after the doors had been opened. Fly-proof screening was kept over all apertures so that the quarantine should not be in any way affected. Ventilation was continued for at least 12 hours, after which a further charge, followed by another ventilation was given. On the occasion of the first shipment three charges of gas were introduced, but for subsequent shipments two were found sufficient to give a satisfactory degree of colouring.

10. As no proper packing-house arrangements were available the culling and sizing of the fruit was carried on in as simple a manner as possible. All fruit exhibiting signs of fruit-fly, bruising, or skin damage were discarded and the remainder passed through a locally-constructed sizing machine which consisted of two tapering rollers set on a slant above a series of canvas bottomed shoots. The rollers were rotated in opposite directions, so that their surfaces travelled upwards and outwards, by means of an electric motor working through reduction pulleys. It was found that the machine was capable of sizing upwards of 50 cases of fruit per hour.

11. The fruits were then wrapped individually in white cap paper cut to the sizes required and packed in accordance with their sizes in cases of South African pattern. The arrangement of the fruits in the case was decided by their sizes and was carried on as indicated by packing diagrams which had been supplied from South Africa. The boxes used were made by Messrs. Marlows Limited of planed Kauvula timber. The wood was unseasoned and the cases were therefore piled with ample ventilation between them in an open shed for a few days before they were used. They were constructed as nearly as possible to the specification set out on page eight of the *Agricultural Journal* No. 1 of 1930, except that no cleats were used. Cases for mandarins were of 26 in. by 12 in. and 4½ in. deep outside measurement. Each case was branded with a Fijian head in black and marked in red with the number of fruits it contained.

12. Four shipments of fruit were made in all comprising oranges and mandarins from Nasinu, a small quantity of limes from Beqa and seedless limes and oranges from Taveuni. Details of two of these shipments will be found in the appendix.

13. The shipment of May 5th comprised ten cases of oranges and one case of limes. The market report stated that the shipment was a vast improvement on the bulk of oranges sent from Fiji. The price realised averaged approximately 4s. per case more than ordinary lines. In this connection it should be noted that the cases used were of smaller capacity than those normally employed, so that the difference in price was even greater than 4s. in favour of the Departmental consignment. In regard to the limes it was stated that there was no great demand, but a small trade of from 20 to 50 cases a month throughout the year could be worked up. The gross return in respect of the oranges was £8 7s. 3d., an average of 16s. 8·7d. per case, from which must be deducted transport, packing, freight, commission, wharfage and cartage, amounting to 7s. 8d. per case, leaving a nett return at the plantation of 9s. per case. The average number of fruit per case was 207.

14. Fourteen cases of oranges treated in a similar manner were shipped on May 23rd. Results from this consignment were disappointing owing to the fact that it arrived immediately after a very large shipment from Raratonga. The return after paying freight, wharfage, cartage and commission was only £1 11s. 7d. out of which the cost of cases, transport and packing had to be met.

15. On the 4th June, 27 cases of mandarins were forwarded to Auckland. The number of fruits per case varied from 64 to 120 according to the size. The cases used were as described in paragraph 11. The consignees reported that the condition of the fruit was excellent, as was also the colour and quality. They said that the market was not strong owing to the arrival of large quantities of Australian fruit which was being sold at low prices. The returns, however, were excellent. The fruit sold at prices ranging from 8s. to 12s. 6d. per case. The total amount realised was £13 19s. 6d., an average gross return of 9s. 7·6d. per case. Transport, cases, freight, wharfage and commission cost 4s. 6·74d. per case giving a nett return averaging 5s. 0·84d. per case on the plantation. The average number of fruit per case was 88, so that the value of the fruit on the plantation after removal from the trees was ·7d. each.

16. The final shipment was made on the 12th June and consisted of nine cases of oranges and two cases of seedless limes from Taveuni, with four cases of oranges and 18 cases of mandarins from Nasinu. The Firm to whom these were consigned reported that the oranges had been perfectly packed, but that the fruit had been somewhat spoiled in fumigation. The prices obtained were low owing to the simultaneous arrival of Cook Island fruit. The mandarins arrived in good order but again the market was overstocked owing to heavy consignments arriving from Sydney. The consignees stated that the fruit itself compared favourably with Australian fruit and would bring remunerative prices if it could be placed on the market earlier in the season. This statement was supported by the returns for the former shipment of mandarins already referred to. The report said that the demand for limes is assured as soon as the fruit becomes better known.

17. In spite of the depressing tone of the report the account sales were quite satisfactory considering the season and the condition of the oranges.

These were known to have been left on the trees rather too long and this fact, coupled with the time that elapsed between harvesting and shipment, would fully account for the statement that they appeared to have been spoiled during fumigation. The object was to test the possibility of profitable marketing of fruit from more distant parts of the Group and the trial indicated clearly that in future seasons earlier harvesting combined with careful handling and packing would ensure profitable returns.

18. The gross return for the nine cases of oranges was £4 4s., an average of 9s. 4d. per case. Freight, Suva–Auckland, commission, &c., cost 35s. 4d., and cases 15s., while freight, Taveuni–Suva, was 12s. 9d. Other costs amounting to 4s. 10d. were incurred for cartage from Suva wharf to the packing-shed and return and for wrapping paper, of which 3s. 3d. would have been saved had it not been necessary to quarantine, size and pack at Suva. The total charges were £3 7s. 4d., leaving a balance of 16s. 8d for nine cases on the plantation, or 19s. 11d. were the avoidable Suva charges omitted. Under normal circumstances the freight from Taveuni for a commercial consignment would have been less and the cost of extra handling in Suva unnecessary. The net return on the plantation in Taveuni for limes was 11s. 10d. for two cases.

19. From a commercial point of view such a small shipment would be unattractive to the producer, but the trial demonstrated that fruit of this class could be successfully exported from more distant parts of the Group, if proper arrangements for quarantine and packing were made at or near the districts where it was grown.

20. The oranges and mandarins grown at Nasinu and exported on this occasion gave better returns because of the lower internal charges, and though the result was not so satisfactory as with earlier shipments, oranges returned an average of 3s. 3d. per case and mandarins 1s. 8d. per case at the plantation. Oranges averaged 237 fruits per case and mandarins 103.

21. During the period covered by these trials, correspondence regarding the quality of Fiji citrus fruit passed between the Department and the Auckland Fruit Importers' Association. The latter organisation called attention to the shipment of sour fruit from Fiji and remarked on the low prices obtained for it. It was pointed out that oranges from the Cook Islands were required to conform to a standard sugar content.

22. This aspect of the citrus export business is one which receives attention in most countries where the fruit is grown. It is to the interest of the grower and exporter to ensure that fruit is of marketable quality, or in other words of the nature substance and quality demanded by the purchaser. The desire to get fruit on to the New Zealand market early in the season has encouraged those engaged in the trade in Fiji to ship immature fruit, whereby they have in many cases spoiled their market for consignments of better quality.

23. It is possible by a simple test to ascertain whether oranges are sufficiently ripe, that is whether the juice contains the proportion of sugar to acid which commends the flavour to the consumer. To endeavour to foist fruit which is not of prime quality on the market is to say the least unwise; but the practice has in the past been not uncommon and regulations have been introduced in other countries to prevent it. In Australia the danger is realised and in recent recommendations of the Citrus Preservaton Committee (2) it is stated that " the harmful effect on the trade would be very great if sour or immature oranges were included."

24. The trial shipments of the past season have indicated that a good seasonal market exists in New Zealand for properly packed Fiji oranges and mandarins of good quality. It appears risky to ship to New Zealand after the middle of May owing to the supplies of fruit forthcoming from other South Pacific Islands, but from that time to the end of the Fiji season there appear to to be good prospects of profitable marketing in Vancouver. Fiji fruit of excellent quality could be placed in that market before Australian supplies begin to arrive. Enquiries are being pursued in Vancouver with the object of arranging trial shipments in 1932.

25. The trials demonstrated forcibly that there is a keen demand in New Zealand for citrus fruit of good quality, attractively packed and that proper attention to the handling of the citrus crop of Fiji would lead to profitable returns. The conditions imposed by New Zealand render it necessary, as has been pointed out, to keep the fruit in fly-proof quarantine for a period of seven days prior to shipment. Not only is any attack of fruit-fly evident after this period but skin damage occasioned by rough handling shows up distinctly. Were it not for the fact that the time elapsing between shipment and consumption is short, little if any of the Fiji citrus fruit would reach its market in consumable condition. As it is the wastage is abnormally high and the price correspondingly low.

26. The most convenient spot to impose the quarantine is near the Suva wharf and it would be a simple and comparatively inexpensive matter to provide equipment for the sizing, wrapping and packing at that point. The additional expense to shippers would be small as the only extras involved are the cost of the wrapping paper, a little additional labour for proper packing, and a small extra charge for cases of better quality. As it is the whole of the fruit has to be inspected individually at the expiration of the quarantine period and packed under Government supervision. Very little organisation would be necessary to provide for sizing, wrapping and packing by standard methods.

27. So far, then, as arrangements at the port of shipment are concerned the problem is simple of solution, but more difficulty will be experienced in securing the necessary degree of care in harvesting and transport to Suva. These difficulties, however, must be overcome if the industry is to become prosperous and exporters must co-operate with producers to ensure that the necessary care is taken at all stages of the handling of the crop. The cost of the clippers required for harvesting the fruit is small and growers can themselves construct pyramidal ladders for use during harvesting operations in order to avoid damage to the trees. Picking bags are used in many countries, but in Australia the use of a packing-box of a capacity of about half a bushel is recommended. The box should be well padded inside and fitted with straps for hanging across the shoulders.

28. Quoting from recommendations by the Citrus Preservation Committee (2):—

(vii) Care should be taken to see that the fruit is not dropped, but transferred from one receptacle to another with the same care as would be given to eggs. If any orange is accidentally dropped or mishandled in any way during the operation, it should be immediately rejected, as otherwise it may be the means of ruining a whole case of fruit.

(viii) The most suitable type of field box is the box used in the canning industry, namely, a kerosene case cut open on the side with cleats nailed to each end for ease of handling. (Locally, the ordinary banana case forms a suitable field box and has the additional advantage of being suitable for the carriage of the fruit to Suva).

(ix) Care should be taken to see that the field boxes have no inner surface projections of any kind; there should be no nails, protrusions of wood or sharp knot holes, all of which are liable to cause injury to the rind.

29. During transport from the place where the fruit is grown to Suva every care must be taken to avoid shaking the boxes and thus damaging the fruit. At no stage should they be roughly handled. The little extra care will ensure that the oranges are not bruised and will result in considerably less wastage.

30. In countries where the citrus export industry is highly organised even more care is taken than has been indicated in the foregoing remarks. Gloves are required to be worn during the operations of harvesting and packing as it has been found that the slightest scratching on the skin, particularly that caused by the finger nail of a worker, gives rise to infection which results in rotting and loss of fruit. It is however, possible to introduce simple methods which can be gradually developed to that pitch of efficiency which will place Fiji in the position it deserves as a citrus exporting country. It is necessary that all interested in the industry should work together and obey closely any instructions or regulations which may be issued.

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## APPENDIX.

### DETAILS OF SHIPMENTS.

### 1—Shipment of May 6th, 1931.

Total—10 cases oranges, 1 case limes.

| *No. of cases.* | *Size.* | *Average diameter. (inches.)* | *Number of fruits per case.* |
|---|---|---|---|
| 1 | 2 | 2½ | 252 |
| 2 | 3 | 2-9/16 | 226 |
| 4 | 4 | 2¾ | 200 |
| 1 | 5 | 2 7/8 | 176 |
| 1 | Mixed 2 & 6 | 2½ & 3 | 232 |
| 1 | Mixed | .. | 165 |

*Account Sales—Oranges.*

| | |
|---|---|
| 1 at 18/9 .. .. .. .. .. | £0 18 9 |
| 1 at 17/6 .. .. .. .. .. | 0 17 6 |
| 1 at 16/- .. .. .. .. .. | 0 16 0 |
| 2 at 15/- .. .. .. .. .. | 1 10 0 |
| 5 at 17/- .. .. .. .. .. | 4 5 0 |
| | £8 7 3 |

Average gross return per case oranges .. 16s. 8·7d.

*Charges per Case.*

| | s. | d. | |
|---|---|---|---|
| Cost of case .. .. .. | 1 | 8 | |
| Cartage from Nasinu to Suva | 1 | 4·35 | |
| Cartage store to wharf .. | 0 | 2·18 | |
| Freight . .. .. .. | 2 | 10 | |
| Wharfage & cartage Auckland | 0 | 5 | |
| Commission .. .. .. | 1 | 3 | |
| | | | 7s. 8·53d. |

Net return at plantation .. .. .. £0 9 0

*Note.*—Cost of wrapping and packing excluded.

*Limes.*

| | |
|---|---|
| Gross return .. .. .. .. .. | £0 15 0 |
| Charges .. .. .. .. .. .. | 0 7 8·5 |
| Net proceeds .. | £0 7 3·5 |

–SHIPMENT OF 4TH JUNE, 1931.

27 cases Mandarins.

| *Serial No.* | *No. of cases.* | *No. of fruits per case.* | *Price per case.* | *Amount.* |
|---|---|---|---|---|
| 1 | 1 | 120 | £0 12 6 | £0 12 6 |
| 2 | 10 | 100 | 0 11 0 | 5 10 0 |
| 3 | 2 | 90 | 0 10 6 | 1 1 0 |
| 4 | 12 | 80 | 0 10 0 | 6 0 0 |
| 5 | 2 | 64 | 0 8 0 | 0 16 0 |
| .. | 27 | .. | ... | £13 19 6 |

Average gross return per case .. 10s. 4·22d.

*Charges per case.*

| | s. | d. | |
|---|---|---|---|
| Cost of case .. .. .. .. .. | 1 | 0 | |
| Cartage .. .. .. .. .. .. | 0 | 6·84 | |
| Freight, wharfage and cartage .. .. | 2 | 3·3 | |
| Commission .. .. .. .. | 0 | 9·22 | |
| | | | 4s. 7·36d. |
| Net return per case .. | | | 5s. 8·86d. |

*Note.*—Cost of packing and wrapping excluded.

REFERENCES.

1. " Fruit Production for Export, Part I, Citrus Fruits," *Agricultural Journal*, Fiji, Vol. 3, No. 1.
2. *Journal of the Council for Scientific and Industrial Research*, Australia, Vol. 4, No. 2, p. 96.

## CITRUS FRUIT PESTS.

By H. W. SIMMONDS, Government Entomologist.

IN the tropics, citrus fruits are normally ripe before changing to a yellow colour; the presence of yellow fruit amongst the green in Fiji can be generally taken to denote insect disease. This may be due to either of the following causes:—

(1) *Fruit-fly* (*Dacus passifloræ*).—This is a black fly, about the size of a house fly and having a yellow scutellum (hind portion of the thorax).

The adult fly punctures the skin of the orange, grapefruit or mandarin and lays several eggs in the puncture thus formed. When these hatch the maggots bore into the tissues of the fruit, which break down and ferment. When the maggots are full-fed they leave the fruit, either before or after it has fallen, and enter the ground to pupate. Such fallen fruit is generally attacked by a number of other insects such as *Drosophila* (ripe-rot flies) and certain beetles, but these are not the primary cause of the rots.

This fly also attacks many other fruits, being particularly abundant in Guava, Kavika and Grenadilla, whilst it is also recorded from Ivi nuts, Sandalwood seed, Pawpaw and cotton bolls. It has not been found in limes or rough lemons.

Until commercial orchards are established in Fiji little can be done in the way of control. In order to prevent infected fruit being exported all oranges, mandarins and grapefruit are held in quarantine by the Department of Agriculture for a period of seven days. At the end of this time the fruit is carefully gone over and repacked, when it is generally possible to detect the infected fruits and discard them. This detection of the breakdown of the tissues is more difficult in thick skinned grapefruits and in loose skinned mandarins, the skin of which does not come into close contact with the diseased tissues. For this reason planters, contemplating an export business, should only grow grafted fruit and should select a tight skinned variety for this purpose.

When commercial orchards are established it will be possible to do much to reduce the incidence of this pest:—

(*a*) by the *prompt* collection and destruction of all fruits showing signs of attack;

(*b*) by destroying any trees in the neighbourhood which act as a " carry over " for the fly between the citrus cropping seasons;

(*c*) it is probable that poison baits or sprays will also be found useful, but this will only be so when the trees are grown under orchard conditions.

(2) *Fruit piercing moth Ophideres fullonica.*—Much of the damage erroneously assigned to fruit-fly is really due to punctures made by an adult moth, *Ophideres fullonica.* This moth is capable of piercing the skin of ripe oranges, bananas, &c., and feeding upon the juice. The breakdown, thus caused, shows as a circular spot, generally about half an inch in diameter as contrasted to the irregular breakdown of the fruit-fly rot. In both cases the fruit yellows prematurely, generally with an orange tint and falls to the ground. There was an enormous amount of damage due to this moth this year on Taveuni.

The adult moth has an expanse of wings of nearly four inches, the front pair being beautifully marbled in greenish brown whilst the hind wings (only visible in flight) are bright yellow banded black.

The larva of the moth is a most striking creature, velvety black with white, red and blue markings and feeds upon the *Drala* tree (*Erythrina* s.p.).

*Control.*—This is difficult. Destruction of all *Erythrina* trees in the district is essential. The moth occurs everywhere to India and should commercial orchards be established it might be possible to obtain some additional biological control to that already present in the country. In South Africa similar damage is done by different species of moths and the following method, recommended by Brain, should also be suitable for Fiji:—

(*a*) 1½ oz. arsenate of lead powder, 53 oz. (⅓ gall.) treacle, 4 gallons water; or

(*b*) ½ oz. arsenate of soda, 53 oz. (⅓ gall.) treacle, 4 gallons water.

Kerosene tins are partly filled with ripe fruit juice and some of one of the above poison mixtures is poured over them. A tin is then hung under every fifth or sixth fruit tree. If a ripe orange is cut in half and placed on the mixture, pulp side up, it is more attractive. Add to the mixture as it evaporates, and remove dead moths.

*Mites.*—In the Cook Islands, but much less frequently in Fiji, oranges in ripening assume a brownish scabbed appearance. This is due to attacks by a mite (*Eriophyes* (*Phytoptus*) *oleivorus*). Such fruit is generally very sweet and in the New Zealand market frequently selected for this reason.

# A METHOD OF CONTROL FOR BANANA BORER
## (*Cosomopolites sordidus*).

By H. W. SIMMONDS, Government Entomologist.

FOR many years entomologists in various parts of the tropics have given much thought and work in an endeavour to discover some method of controlling this beetle, but with little success, the use of the soil fumigant paradichlorobenzine, being the only method showing promise of practical result.

In Fiji some measure of success has been attained by biological methods. The predatory beetle *Plæsius javanus*, introduced in 1913 by Jepson, has become thoroughly established and is undoubtedly doing good.

Nevertheless, the borer remained the most serious of the banana problems in this country as it was established in all parts of the Group and it was impossible to adopt the method used in some portions of the world of obtaining clean plants from non-infected areas for planting-up purposes.

Experiments carried out by this Department showed that, whilst flight undoubtedly occasionally occurred, it was not frequent and was negligible as a means of spreading the pest. It was also found that spreading by crawling was not nearly so rapid as is usually thought to be the case and that clean plants placed beside plants rotten with borer would frequently remain clean at the end of twelve months.

The efforts of the Government Entomologist were therefore concentrated upon devising a means of obtaining clean suckers for planting purposes, as it was felt that if clean plants were used on clean land it would be so long before these plants became severely affected that the grower would be enabled to take his crop and make his profit before this happened. In the efforts to attain this object a considerable measure of success has been attained.

*Method of attack and effect of the banana borer.*—The banana borer (*Cosmopolites sordidus*) lays its eggs just inside the corm of the plant, about the level of the surface of the soil, the eggs being thus most difficult to discover. These eggs hatch within about ten days and the resulting grub bores into the interior of the corm which is often completely tunnelled and rotten with the borings. When the grub is full-fed it approaches the surface of the corm, still remaining inside, where it pupates and, upon completion of its metamorphosis, eats its way out.

The effects of these attacks are twofold—

(1) A considerably reduced bunch of fruit, the plant producing only six or eight hands instead of the proper ten or twelve;

(2) a greatly shortened life to the estate, which gives the appearance of being worked out after 2½ or 3 years, instead of lasting in full bearing for five or seven years.

*Control.*—As the insect lives throughout its earlier stages within the tissues of the corm, with only the minutest connection with the outside air, ordinary fumigating processes are useless. It was, however, thought that the fumigant might be carried into the tunnels by means of a vacuum and tests were carried out, using carbon-di-sulphide as the poison. Some measure of success was attained, but some of the full-fed larvæ and pupæ survived to a point where the plant was killed and it is doubtful if the eggs were affected.

Experiments were then carried out with prolonged soaking and the desired 100 per cent. mortality of borer and eggs was attained by the following method:—

### DIRECTIONS.

(1) Good strong suckers must be selected, having one or more undeveloped lateral eyes in addition to the aerial stem.

(2) These suckers are placed in a tub, punt or other water-tight vessel, with the aerial stem upwards.

(3) They are then covered with fresh water to a depth of about two inches above the point where the stem joins the corm, leaving the aerial stem fully exposed to the air and light.

(4) They are left for 21 days, taking care that the water is maintained during the whole of that period at the same level. This is most important.

(5) After 21 days they are removed and planted out, either in an isolated nursery or in the field.

It will then be found that they die back to the corm and one of the lateral eyes develops, producing in 12 months a bigger and better bunch than would have been the result had the sucker itself grown.

Planters are strongly urged to adopt the above methods either individually or collectively by making nurseries and distributing the resulting plants.

## RAT CONTROL IN COCONUT PLANTATIONS.

425/31.

Department of Agriculture, Suva, Fiji,
9th March, 1931.

Dear Sir,

I have the honour to seek your co-operation and assistance in dealing with the serious local problem of rat control in coconut plantations. The depredations of the rat are by no means confined to coconuts, but in Fiji it is found that its effect is most marked in relation to copra production and that the annual loss is of the order of 7 per cent. of the crop (" Early Nutfall from Coconut Palms in Fiji," by T. H. C. Taylor, B.Sc. (Lond.) ).

2. The rodents live in the trees and appear to confine their activities to particular groups of trees in a plantation. Surridge has investigated the problem and has suggested remedial measures which are given in the Fiji *Agricultural Journal* No. 3 of 1930.

3. The use of a virus has been advocated and I observe that a new rat virus prepared by the Pasteur Institute, Paris, has been put on the market. Local opinions differ as to the advisability of introducing this or any other virus to Fiji. The Chief Medical Officer and the Senior Veterinary Officer do not support its introduction.

4. Attempts have been made to control the pest by predacious birds and animals. There are local owls which are said to feed their young exclusively on rats and something might be done to increase their numbers by providing special breeding places. This work could only be done by an expert.

5. The masked owl was imported from Tasmania in 1929, but owing to the sudden attack of those introduced upon young farm-yard birds as soon as they were liberated, the move was not popular, and nothing is known as yet of the effects of those eventually set free in a coconut plantation.

6. The mongoose was also introduced, with the object of controlling rats in sugar-cane areas, but local legislation prohibits its introduction to other islands in the Group and popular opinion is averse to any lifting of the ban.

7. There is an undoubted lack of co-operative effort on the part of owners of coconut plantations and the problem is a proper one for the Coconut Committee of Fiji to deal with on similar lines to the methods adopted for the control of disease and loss occasioned by insects. The Committee has given much attention to the matter, and at a later date may be able to engage a special officer to inaugurate an organised campaign in somewhat the same way as was done in Cyprus.

8. I should, therefore, be grateful for your advice on the following points:—

(*a*) the use of viruses; those recommended; objection, if any, to their employment;

(*b*) the possible introduction of other means of control than those already tried locally;

(*c*) the prospects of securing the services of an experienced man, capable of organising a rat-control campaign in Fiji.

9. I forward for your information copies of Departmental publications on the subject.

I have, &c.,

DIRECTOR OF AGRICULTURE.

The Director, Imperial Institute,
Kensington, London, S.W.

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Imperial Institute, South Kensington, London, S.W. 7,
19th May, 1931.

Sir,

In reply to your letter 425/31 of 9th March I have pleasure in forwarding you the following information on rat destruction, with special reference to the points you have raised.

Rats do much damage to tree crops in many parts of the tropics, but as they do not usually live in the trees they can often be dealt with fairly effectively by well-known methods, such as the use of poisons and traps, and also by introducing carbon bisulphide, sulphur dioxide, &c., into their burrows.

The special difficulty due to the rats spending all or most of their time actually in the trees appears to be largely confined to your region of the world.

In Papua (see *Bulletin* No. 8 ,1918, of the Department of Agriculture) trouble resulting from this habit of life is reported. It was apparently not very serious at the date mentioned and poisoning with white arsenic proved usually satisfactory. The poison was dusted on the cut surfaces of sweet potatoes, ripe bananas, or sugar-cane joints, cut lengthwise and the parts skewered together again.

In Fanning Island, according to an inquiry received this year at the Imperial Institute, the problem is evidently very similar to yours. A great deal of damage is done by rats which seldom or never come to ground and no satisfactory method of dealing with them has yet been found.

In French Oceania rats inhabiting coconut palms are also a very serious pest. The most satisfactory method found there for preventing their ravages has been banding the trees with sheet zinc. In *Bulletin des Matieres Grasses de l'Institut Colonial*, 1928, No. 4, 118–130, and 1929, No. 10, 316–17, an account is given of the action taken by the Government to arrange for the importation of very large numbers of sheets of zinc. Such work would of course have to be undertaken in a systematic manner, isolated blocks of trees being banded and then the rats dislodged from their crowns. By the use of zinc sheets the difficulty due to galvanized iron or tin bands becoming rusty, as mentioned in your *Agricultural Circular* V, No. 2, would be avoided.

You could doubtless obtain later information on the progress and success or otherwise of the scheme from the Chambre d'Agriculture des Etablissements Francais de l'Oceanie.

On the question of viruses the best authoritative opinion obtainable is definitely against their use.

I enclose copies of a letter, memorandum and leaflet received from the Ministry of Agriculture and Fisheries. In the first it is stated that " the Ministry does not recommend the use of virus preparations for rat destruction. Its attention has been drawn to the reported discovery of a new rat virus by the Pasteur Institute, but as a result of inquiries which have been made in connection therewith the Ministry can see no reason to depart from the opinion referred to in the leaflet."

The United States Department of Agriculture holds a similar view on the use of viruses, as indicated by the following extract from the new edition of their *Farmers' Bulletin* No. 1533 on " Rat Control " issued June, 1930:—

> " Rat viruses on the American market contain living organisms, or bacteria, known as the Danysz bacillus, which when ingested by rats is said to cause a disease that is followed by great mortality. In extensive experiments with rats conducted by bacteriologists of the Department of Agriculture, however, even the most virulent cultures failed to produce a high percentage of deaths, while the majority of the viruses tested were practically ineffective. Also the disease produced was found not to be contagious, except when one rat ate another. Thus there is little probability of the disease spreading to an appreciable extent. There also appears to be well-founded doubt as to the harmlessness of rat viruses. The Danysz bacillus belongs to the same group as the food poisoning bacilli and is indistinguishable from them. Although it has not been possible directly to trace many cases of human food poisoning to rat viruses, two State boards of health have prohibited their sale within the States. For these reasons the department does not recommend the use of viruses for the destruction of rats."

Your question in regard to securing the services of an experienced man capable of organizing a rat control campaign is answered in the enclosed letter from the Ministry of Agriculture. Application was made to the Ministry as the latter had arranged for the Cyprus Government to obtain the services of such an officer.

I am, &c.,

S. E. CHANDLER,
for the Director.

The Director of Agriculture,
Suva, Fiji.

## MEMORANDUM ON THE USE OF VIRUSES FOR THE DESTRUCTION OF RATS.

(*Prepared by the Ministry of Agriculture and Fisheries.*)

1. It has been the consistent policy of the Ministry of Agriculture and Fisheries not to recognise officially the use of viruses consisting of cultures of microbes causing intestinal diseases for the destruction of rats and mice. The position is explained in the Ministry's Leaflet No. 244, page 7, a copy of which is attached.

In connection with the experiments conducted by the Zoological Society of London on behalf of this Ministry and the Ministry of Health in 1919 with a view to ascertaining the most successful means of combating rats and mice, preparations of viruses were also tried and the report on their use is as follows:—

> " The discovery some time back of a bacillus pathogenic to rodents led to a new method for the destruction of rats and mice. Following this discovery, the virulence of the organism was raised by artificial methods in the laboratory and a number of rat viruses were placed on the market.
>
> The manufacturers of these claimed that the bacillus was so virulent that it would kill rodents in about 10 days, and that within a month the disease would spread with fatal results to the whole of the rat (*or mouse*) population of the area under treatment. The results of recent investigation on the efficiency of some of the viruses on the market have been disappointing. Bainbridge has experimented on a very large number of rats in captivity, and the results of his experiments showed that the destructive power of all the viruses he tested was inconstant, the death-rate in the different experiments varying from 20 to 50 per cent. Further, according to this experimenter the presence of agglutinins in the serum of the rats which survived after being fed on virus gave reason to suppose that a certain proportion acquired immunity and were therefore unlikely to succumb to a second infection.
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> Experiments with the rat-viruses conducted some years ago during the outbreak of plague in San Francisco also gave poor results.
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> It must be recognised that, if generally successful, this method of exterminating rats and mice by spreading among them a disease, not affecting man and domestic animals, could not be improved upon, and I was therefore anxious to give a thorough test to all the viruses on the market in the hope that the results of the experiments under natural conditions would differ from those obtained in the laboratory.
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> In all seven tests were made with different virus preparations, and of these one only was an unqualified success; three were partial successes, a very slight reduction in the number of rats being recorded, and three were absolute failures. The experience of a number of reliable witnesses indicated that the successes in these cases amounted to about 33 per cent.
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> No further official tests have been made in this country but many reports have been received, most of which state that the results obtained by using viruses are disappointing. These may be due to conditions of temperature, immunity of rats and mice eating the baits containing the germ or to the viruses not being in a pathogenical condition owing to length of manufacture, weakness of the strain of bacillus used or contamination with moulds, or other germs. However, on the Continent a great deal of experience has been obtained.

> According to Dr. Hans Wreschner in a report contained in the *Zeitschrift fur Hygiene und Infections Krankheiten*, 93 Vol., 1921, pp. 35–42, it was found that Danysz and ratin viruses, amongst others, were the cause of illnesses and deaths in human beings in Germany and Switzerland, and it is this official's opinion that such bacterial preparations should only be used away from human habitations owing to the potential danger to man and domestic animals.
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> In a report of June, 1924, by A. Moncke, a practical worker with viruses, it was stated that ratin had not been proved to be harmless to human beings, and that he had himself suffered from such an infection."

In the Annual Report of the Medical Officer of Health for the City of London for 1924 the following remarks were made:—

> " In spite of the discouragement of its use by the Ministry of Agriculture and representations to the Government by the City Corporation, rat virus is still being largely used in many premises. The experiences gained in the City does not bear out the claim that rats and mice die in the open after being poisoned by virus, as complaints have been made of the nuisance of dead rats between match-boarding and walls and under floors in premises where virus has been used.
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> By a general Army Order, dated July 29th, 1919, the use of any vermin-destroying virus preparation is prohibited in all military establishment and camps, the reasons stated for their prohibition being (1) they are apt to produce a rat population which is immune to the action of the virus, (2) there is a certain degree of risk of food contamination, with resultant food-poisoning outbreaks.
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> Experience in the City has proved that both these reasons are sound. It is regrettable that the civilian population is not afforded the same protection from food poisoning outbreaks as that which the Military Authorities afford the Army by prohibiting the use of virus. It probably kills only 50 to 60 per cent. of the rats and should be condemned for that reason alone."

Some short time ago I drew the attention of a firm of food manufacturers in this country to the question of discontinuing the use of virus on their premises. They had obtained the virus from Holland, and the Ministry of Health in this country reported as follows:—

> " The material yielded a profuse growth of *B. enteritidis* (Gaertner); this organism may be pathogenic for human beings and domestic animals.
>
> This Department do not regard with favour the use of these viruses as they are attendant with a risk to human health.
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> The organism invariably employed is one of the food-poisoning group and infected rats recovering from the illness may retain these organisms in their intestines for long periods, with the possibility of contaminating human food with an infection which is highly pathogenic."

It is understood that the use of this virus has now been discontinued both in the English and the Dutch factories.

The following is an extract from the Annual Report for 1925 of the Surgeon-General of the U.S.A. dealing with plague suppressive measures in Oakland, California:—

> " Moreover, the results of trappings are definite, whereas poisoning results are problematic. A biologic poison known as ratin was tried, but the opinion formed was that poisoning was of no great

value. Better results, however, were obtained with ratinin—a preparation of squill and it seemed evident that poisoning by squill was of distinct value.

At least two of the commercial firms engaged in marketing so-called " rat viruses " that are claimed to create an epizootic gastroenteritis in rodent population, advocate and practice a system of double poisoning, the first by a virus and second by a chemical poison. It seems pertinent to suggest at this time that whatever values these systems possess is probably due to the chemical poison, not to the virus, and that the former could be used as effectively and much more cheaply under their correct designation rather than as a proprietary product."

2. The use of a virus on an extensive scale is undoubtedly much more expensive than the application of safe poisons or even dangerous poisons. If the circumstances permit, gassing is a comparatively cheap way of destroying rats, especially if labour is inexpensive. It is difficult to give exact figures, but some years ago a campaign was organized in the City of Birmingham and some hundreds of pounds were spent in applying Liverpool virus. A subsequent application of a bait containing barium carbonate was said to have been quite as, if not more, efficacious than the use of virus and the cost was many times less. A leaflet (D.R.I.) giving notes for the guidance of officers appointed to supervise measures for the destruction of rats and mice is attached.

The danger to domestic and undomestic animals has been briefly dealt with under 1. In this country and on the Continent rodents other than rats and mice have been affected by the use of viruses and it has been stated that the domestic animals have also suffered. Above all the use of a disease spreading rat poison should be only pathogenic to rats and mice. All preparations I have had to deal with hitherto do not conform to this standard. In addition immunity plays a dominant role in the question of destruction and nearly all makers of virus supplement their bacterial preparation with a secondary one, invariably a red squill preparation in order to obtain 100 per cent. kill. This is not logical, because if the secondary preparation is necessary to obtain 100 per cent. kill it should be used in the first instance as advocated by this Ministry and not to patch up the fallacies of the virus application. It must be admitted that if conditions are favourable and expense is no object the use of a virus will weaken the strain of rats and make them more susceptible to the use of a secondary preparation, but this is more a matter of theory than of practical rat destruction.

### EXTRACT FROM " NATURE," APRIL 4, 1931, PAGE 532.

The value of red squill powder in the destruction of rats is becoming increasingly recognised. When experiments were carried out in the Zoological Gardens in London some years ago, it was found that the liquid preparation of red squill (a liliaceous plant known also as scilla and sea-onion, *Urginea maritima*) was more trustworthy than powder mixtures. Since 1923, however, the United States Department of Agriculture has been experimenting with the powdered forms, and it has been found that a powder of maximum toxicity can be obtained by drying the sliced bulbs at a constant temperature of 80 degrees C. Thus the greatest difficulty in the use of red squill, irregularity of results, has been overcome, and the poison has become the most widely used against rats in the United States. It is greatly in its favour that this rat poison is relatively harmless to human beings and domestic animals; indeed, in field tests, prairie dogs and pocket gophers refused to eat the red squill baits, and in most cases cats, dogs, chickens, pigeons and pigs either refused to eat poisoned foods or, having eaten, promptly vomited them. One of the authors of the new United States Department of Agriculture *Leaflet* 65, " Red Squill Powder and Rat Control," himself swallowed 15-grain and 40-grain doses of a toxic red squill powder without untoward results.

## GRADING OF COPRA FOR EXPORT.

Imperial Institute, London, S.W.7,
6th March, 1931.

Sir,

With further reference to your letter No. 1300/30 of the 15th August last and in continuation of my letter of the 3rd October regarding the grading of copra for export, I have to state that the questions involved have now been fully considered by our Advisory Committee on Oils and Oilseeds, in consultation with the London Copra Association and other exports, and I send herewith a memorandum summarising the various recommendations obtained.

If further steps are taken with a view to the grading of Fiji copra, the Imperial Institute will be glad to receive as suggested in the memorandum, experimental samples of the proposed grades for submission to trade experts. We shall also be glad to be of any further assistance which may be possible.

It was hoped to send you with this memorandum a set of samples representing the usual commercial grades of copra now on the London market, which were promised by one of the firms consulted. These have not yet been received however and the memorandum is now being forwarded without them in order to avoid further delay. The samples will be despatched to you immediately they are received.

I am, &c.,

The Director of Agriculture, Fiji.

HAROLD BROWN,
for Director.

### THE IMPROVEMENT AND GRADING OF FIJI COPRA FOR THE MARKET.

*Grading.*—It is considered that the grading of copra prior to export from Fiji should contribute towards the improvement of the quality of this product entering the world's market. In this connection it would be advisable to restrict the number of grades to two, the better of which would represent a quality intermediate between that of Straits and Ceylon copra. In the event of a decision to adopt grading, it is suggested that, before such grading is put into force, samples of the proposed grades should be forwarded to the Imperial Institute in order that the opinion of the trade may be obtained upon them.

*Quality.*—The following characteristics are considered in judging the value of copra:—

*Size of pieces.*—Large pieces are preferred by the trade. In small pieces the acidity of the oil tends to be higher. On the other hand, small pieces dry more rapidly and can be packed more compactly.

*Thickness.*—Thick copra is preferred to thin. Thinness suggests that the copra has been prepared from nuts which were under-ripe.

*Colour.*—The inner surface of copra should be as light-coloured as possible. It is more important, however, that the pieces internally (*i.e.*, on being cut through) should not show any discolouration.

*Brittleness.*—Many manufacturers prefer a brittle copra as they find such a copra gives a more satisfactory result on crushing. The drying should be controlled to prevent the copra from becoming horny through too rapid drying.

*Mould and insect attack.*—The presence of mould, especially of black mould, detracts from the value as does also damage by insect attack.

In the light of the above desiderata for copra of good quality, it would appear that the chief defect of the present Fiji product is its poor colour. This is possibly due to some extent, if not entirely, to lack of sufficient care in protecting the nuts from rain during the drying process or from damp during storage. Care should also be taken to use only ripe nuts, and these with advantage might be cut into quarters instead of into a large number of pieces. The drying should be so controlled that the products does not become horny or discoloured internally.

*Increased price.*—If the copra can be improved in quality, the best way to obtain an enhanced price for it would be to market it on type, *i.e.*, to sell consignments on sample and not merely as " Plantation Fiji " or Fiji Copra." Care would of course have to be taken in such case that the bulk consignment was equal in quality to the sample. When offered in this way there should be a greater chance of obtaining a premium over the market price of the Fiji copra at present exported. In general the minimum shipment of any new grade of copra should be from 100 to 200 tons.

If, however, the present method of marketing be followed in the case of an improved quality of Fiji copra, it is not likely that an enhanced price will be received immediately, but if the improvement is permanent and buyers become able to rely upon the maintenance of the quality, such copra may ultimately fetch a price slightly higher than that paid for the ordinary grade of Fiji copra. As was the case with Crown Estates Samoan copra (which is now selling at a slight premium) it would probably take several years for an improved grade from Fiji to receive this recognition in the market.

*Conclusions.*—The improvement of the quality of Fiji copra is desirable and may be effected by taking the precautions outlined above. If grading is adopted the number of grades should be restricted to two. If the quality is improved an enhanced price may eventually be obtained. Whether the increase in price will be justified by the increased cost of preparation can only be determined in Fiji but even if the increase is small the improvement in quality should lead ultimately to an extended demand for Fiji copra.

## THE GRADING OF FIJI COPRA.

By A. C. Barnes, Director of Agriculture.

The question as to whether Fiji copra should be graded or not has been under consideration for several years. The subject was referred to in the Governor's Speech to Legislative Council on the 22nd November, 1926, and a Select Committee was appointed to consider a Draft Bill to raise the standard of copra produced in the Colony and to prevent the export of inferior copra. The report of this Committee was published as Council Paper No. 4 of 1927 which includes a memorandum from Sir Maynard Hedstrom and a

Draft Bill which, with amendments to be referred to later, was ultimately passed. This Bill in its original form included provisions for the compulsory grading of copra. The Committee's report was discussed at length by the Legislative Council on the 2nd June, 1927 (reference Fiji Legislative Council *Debates* 1927, pages 90–97).

2. A motion was approved for the introduction of a Bill at a subsequent session. The Bill was read for the first time on the 17th October, 1927, and the second reading was taken on the 24th October. During the debate His Excellency the Governor stated that it was proposed to amend the title of the Bill so that it would not refer in any way to a Bill to prevent the export of inferior copra from the Colony and indicated that the Bill as proposed to the Council would not interfere with the carrying on of the export trade of copra as it then existed. It was hoped that permissive instead of compulsory grading would provide the necessary incentive, both to Europeans and to natives, gradually to improve the quality of copra so that it might be graded officially as first or second grade copra.

3. The general effect of amendments to the original Bill which caused it to be presented to Council in modified form and of amendments made during its passage through Council altered completely the effect of the Bill in so far as grading of Fiji copra is concerned. Subsequent amendments passed at later sessions of Legislative Council did not improve in any way the position regarding grading nor did Proclamations under Section 15 apply the permissive grading sections to any part of the Colony so that they may be said to have exercised no effect whatsoever on the quality of Fiji copra.

4. The Coconut Planters' Union have at all times supported the proposal to grade Fiji copra and to establish definite standards of quality. Since May, 1930, they have renewed their efforts to secure the introduction of a workable system of export inspection and grading. As Director of Agriculture I have paid close attention to this matter since my arrival in the Colony and have taken steps to secure information from the Imperial Institute regarding comparative market prices of copra from different exporting countries as well as on copra grading and the standards of quality most likely to commend themselves to the market. In a letter dated 17th April, 1930, replying to a request from me, the Director of the Imperial Institute kindly offered to furnish such information as was available and to send at regular intervals copies of market reports from Messrs. L. M. Fischel & Co. Ltd. This correspondence was published in *Agricultural Journal* No. 2 of 1930, together with copies of remarks on copra and coconut oil published in the *Trade Review* on the oil and oil-seed markets during 1929.

5. His Excellency received a deputation of the Directors of the Coconut Planters' Union Ltd. on the 4th June, 1930. The Acting Colonial Secretary and myself were present. The deputation handed to His Excellency a copy of a circular letter which had been forwarded to all members of the Union, and shippers and other persons interested in the production and export of Fiji copra. Other papers presented were a letter from the Directors, copra market reports from Messrs. L. M. Fischel & Co. Ltd., and a reprint of an article on Fiji copra by Clive Joske. The object of the deputation was to bring to the notice of His Excellency the history of attempts to introduce copra grading, the objection to the principle of voluntary grading provided for in the Copra Ordinance 1927, and the desirability of making early provision for the compulsory grading of all copra exported from Fiji. The deputation urged that the London Copra Association should be consulted

and that if and when compulsory grading were introduced that Association should select a man for the post of Inspector and Grader.

6. His Excellency ordered me to make a record of the proceedings and to prepare a memorandum for the consideration of Executive Council. In the course of the discussion the Acting Colonial Secretary said that the system of permissive grading was introduced in order to give an opportunity of demonstrating the advantages of grading to native producers, but he agreed that as no grading had yet been done the time appeared now to be ripe to consider the introduction of compulsory grading.

7. Action has been continued during the period elapsing since the date of the interview, and communications have passed between myself, the Coconut Planters' Union Ltd. and the Imperial Institute, London. That correspondence may be summarised as follows:—

(*a*) Letter dated 18th June, 1930, from the Director of Agriculture to the Secretary, Coconut Planters' Union Ltd., Suva, referring to the interview between His Excellency the Governor and the deputation from the Union and asking them for forms of contract for copra approved by the London Copra Association, together with information regarding the characteristics which determine the relative market values of various grades of copra and the minimum shipments of high grade copra which would command prices in accordance with their quality. The desirability of reducing storage and transport costs was urged and it was pointed out that careful methods of preparation yielded not only a product of better value but a greater amount of copra from the same quantity of raw material. Reference was made to an article on mould damage to copra in *Agricultural Journal* No. 2 of 1930.

8.—(*b*) Letter from the Secretary, Coconut Planters' Union Ltd., dated 21st June, 1930, formally acknowledging (*a*).

9.—(*c*) Letter from the Coconut Planters' Union Ltd. to Director of Agriculture dated 3rd July, 1930, forwarding copies of two forms of contract upon which all copra sales take place in or through London and suggesting that the Imperial Institute communicate direct with the London Copra Association in regard to matters referred to in (*a*). A recent market circular from L. M. Fischel & Co. Ltd. was forwarded. It was stated that at least 25 per cent. of Fiji copra was now or could easily be made of F.M.S. Straits quality as most plantations of any size were equipped with driers.

10.—(*d*) Letter dated 15th August, 1930, from the Director of Agriculture to the Secretary, Coconut Planters' Union Ltd., acknowledging (*c*) and submitting suggestions for consideration regarding the possibility of producers of good quality copra shipping their copra under distinctive marks to Suva where inspection could be made and consignments officially branded for export. It was suggested that producers of high grade copra might be registered and required to maintain the standards of quality specified for grades decided upon as a condition of registration.

11.—(*e*) Letter from the Director of Agriculture to the Director of the Imperial Institute dated 15th August, 1930, asking for information in regard to copra grading and standards of quality. It was suggested that the Institute should communicate direct with the London Copra Association in regard to the characteristics as judged by cursory and superficial examination which determined the relative market value of various grades of copra and the minimum shipments of good quality copra which would command higher prices.

12.—(*f*) Letter from the Secretary, Coconut Planters' Union Ltd., to Director of Agriculture dated 29th August, 1930, stating that no practical advantage was likely to be gained by the system suggested in (*d*). It was considered that unless the principle of grading were adopted by all in Fiji, few planters would attempt to grade their copra on the estates into what they considered to be export grades. The only point at which copra grading could usefully be employed was at the port of export. It was essential that the system be a compulsory one; the salaries of the staff necessary might be provided by a levy on exported copra. Reference was made to co-operation by the Empire Marketing Board.

13.—(*g*) Letter from the Director of the Imperial Institute to Director of Agriculture dated 3rd October, 1930, acknowledging (*e*).

14.—(*h*) Letter from the Director of the Imperial Institute to Director of Agriculture dated 6th March, 1931, forwarding a memorandum on the matter of grading of Fiji copra for the market and referring to a set of samples representing the usual commercial grades of copra which would be despatched at a later date. The memorandum forms Appendix 1.* Copies of this letter and the memorandum were forwarded to the Directors of the Coconut Planters' Union Ltd. and to other gentlemen interested in copra production and export and their comments were invited.

15. On June 23rd, 1931, a deputation from the Coconut Planters' Union Ltd. was received by His Excellency the Governor when a memorandum was presented outlining a scheme for export copra grading. It was pointed out that the most powerful inducement to the production of first grade copra was some direct financial benefit and a graduated export tax on copra was proposed with provision for the payment of a bonus on first grade copra at the expense of the lower grades. The scheme was outlined in the memorandum as follows:—

(1) copra to be graded at Suva and Levuka by special graders appointed through the London Copra Association;
(2) no charge to be made for grading at Suva and Levuka (two principal export points);
(3) exporters to be free to ship from other ports ungraded, but to be allowed to make special arrangements for grading at outside ports at their own expense. (On somewhat parallel conditions to those upon which ships are permitted to take Customs officers from Suva or Levuka and load cargo at other than ports of entry);
(4) three grades of copra to be established with such names as " Fiji Plantation," " Fiji F.M.S.," and no name;
(5) no export tax to be levied on copra graded as " Fiji Plantation "; " Fiji F.M.S." to pay 1 per cent., or whatever is regarded as the normal rate of tax for the time being; the unnamed copra to pay double that tax;
(6) a bonus of 2s. 6d. per ton to be paid on all copra graded as " Fiji Plantation."

16. Messrs. L. M. Fischel & Co. Ltd's market reports have been received regularly from the Director of the Imperial Institute. In spite of the almost continuous fall in market prices to the beginning of June, 1931, those reports indicate that the higher values of Ceylon F.M.S. and Singapore F.M.S. continue to be a feature of the market. Under date 29th April, 1931, the market price of South Sea F.M.S. c.i.f. Northern European ports was £13 12s. 6d., prices for Ceylon and Singapore F.M.S. being £15 2s. 6d. and £14 2s. 6d. respectively.

17. Late in 1930 it was reported that San Francisco buyers had lost interest in copra shipped direct from Rotuma because of its inferior quality

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* See pp. 70–71.

and that if early steps were not taken to deal with the situation Rotuman producers might find themselves without a market. A Firm of San Francisco importers stated definitely that their crushers were generally loath to contract for any Fiji sun-dried copra because of the extreme variation in the quality of the lots received.

18. The position now reached is that a strong body of opinion representative of producers in Fiji supports the introduction of a system of export grading of copra under marks which will indicate to the overseas purchaser the standard of quality of individual shipments. Consumers, that is to say, crushers, would welcome the opportunity of securing parcels of Fiji copra of certified quality. Local merchants in most cases, if not definitely antagonistic to export grading, appear not to be entirely in favour of it. Although merchants' interests must receive some consideration in connection with a problem of this nature it should be borne in mind that they act as the intermediary between the producer and the consumer and if both producer and consumer are in favour of compulsory fixation of standards of quality and export grading the merchants should be prepared to fall into line.

19. The present Copra Ordinance with its permissive system of grading has not had the desired effect, and to attempt to administer it in its present form in so far as its grading provisions are concerned would prove a costly and ineffective experiment. Under present circumstances the incentive to produce copra of high quality is lacking except in cases where producers make a sufficient quantity to warrant shipment under their own brand to a consumer whom they have been able to satisfy in regard to maintenance of satisfactory standards of quality of their copra. Without an established system of copra grading, purchasers of Fiji copra have to safeguard themselves against its low quality and they therefore fix the price on the basis of the worst they expect to receive. The resultant discouragement to those who would and could produce a better quality article is obvious.

20. The merchant's point of view can of course, be understood. With a system of compulsory grading of copra he would have to separate good and bad copra in his export shed, instead of mixing it as he does at present. Some trouble would be involved by the work of the Inspector who would require the withdrawal of selected bags of copra for examination. In this way a certain amount of additional handling would be necessary.

21. It is interesting to compare the attitude of local merchant firms to export produce grading with that displayed by merchant firms in other Colonies who are themselves interested not only in the actual purchase of raw produce, but in its utilisation in industry afterwards. In the case of the latter, export produce inspection is welcomed and has, in fact, been definitely pressed as a desirable means of improving standards of quality and of securing higher returns not only to the producers but to the merchant themselves. I know of no case where export produce inspection and grading has not benefited all classes of the producing and merchant communities.

22. The position in regard to copra has undergone a change during recent years. Results of scientific inquiry have been applied industrially to the needs of the edible oil and fat industries and a wider range of oils and fats can now be employed than was the case a few years ago. The effect of the competition of other oils and fats on the value of copra has been shown in a remarkable manner during the past three years and although the almost continuous fall in market prices has not been entirely occasioned by the increased employment of other oils, that has undoubtedly been a very large factor. The user of coconut oil under modern conditions would endeavour to employ the best quality product at a price which suits him and which, at

the same time, will be considerably in excess of that offered for inferior grades. He may still be prepared to purchase those inferior grades but, again at a price which suits him and at a figure which, as has been shown, is considerably below that for superior standard qualities.

23. Fiji copra has long had a bad name. Crushers have often complained about it and attempts have been made to improve the position. The copra Ordinance was originally designed to improve the quality of locally-produced copra by a system of compulsory export grading which was to be supported by the suppression of undesirable practices on the part of the copra producer. It has been shown that the Bill in its passage through Legislative Council lost its original character and that since it became law it has exercised no appreciable effect on the quality of Fiji copra. Whether the position will ever arise when inferior copra will be impossible to sell is a question that time only can answer, but events have shown that in one or two instances Fiji has been dangerously near to that state of affairs. It is reasonable to assume that the Copra Ordinance has been given a fair trial; that it has failed miserably to achieve the purpose for which it was made law; and that the time has now arrived when compulsory grading of copra should be introduced. I recommend therefore that early steps be taken to provide the necessary legislation and to establish the service required.

24. Legal power should be taken either by amendment of the existing Ordinance or by the introduction of a new Bill to empower the Governor by Proclamation to require copra exported from any port or part of the Colony to be inspected, graded and branded prior to shipment. Provision would require to be made for the appointment of Inspectors, the establishment of grades, the manner of inspection, the marking or branding of bags containing copra which had been inspected and graded, the making of regulations and penalties for breach of the Ordinance and regulations.

25. It would be desirable in the first instance to confine export copra inspection and grading to the port of Suva where the work would be under constant and close supervision. After a period, say, one year, the system could be extended to Levuka and to other points of export from the Colony. One Inspector only would be required in the first case, who would be a man of considerable experience whose appointment was approved by the London Copra Association in accordance with the recommendation of the Coconut Planters' Union Ltd. In the course of two years such a man would be able to establish the system on a satisfactory basis and to train other men who would continue the work after the conclusion of his period of engagement.

26. The cost of the service during the first two years would be about £1,700, made up of salary £700 per annum, return passages £250, and incidental expenses £50. Clerical services could be provided by the existing staff of the Agricultural Department. In the third and subsequent years the annual cost should not exceed £580—salary, say, £400 to £500 for the Inspector and Grader, and a small provision for expenses. Inspection would be carried on in exporters' sheds, while labour for the work involved would be provided by the exporter.

27. The scheme could be financed by an export tax on copra, to be administered in a manner to be decided. In this connection the scheme advanced by the Coconut Planters' Union Ltd. could be considered. A tax of 8d. per ton on all copra exported from the Colony would suffice to meet the cost of the inspection and grading service in 1932 and 1933. This would yield £833 in 1932 on an estimated output of 25,000 tons, and £1,000 in 1933 on an estimated output of 30,000 tons. In later years a tax of 4d. per ton

would be enough. A small premium above market prices for second grade copra would more than compensate producers for the cost of the service.

28. The argument will doubtless be adduced that the small premium accruing for higher grade copra will not meet the additional production costs incurred. It has been pointed out that the advantage to the producer is not so much the slightly higher market price for good quality copra, as the increased quantity that can be produced and marketed from the same amount of raw material by the practice of improved methods of preparation. This contention is supported by scientific evidence which clearly shows that incidental losses occasioned by moulds and insects are greatly reduced, with the result that returns per acre are increased and production costs thus lowered.

## NOTES ON COCONUT PESTS AND NOXIOUS WEEDS IN FIJI.

By R. J. A. W. Lever, B.Sc., A.I.C.T.A., F.E.S.

During the months of March and April, 1931, the author, at the suggestion of the Director of Agriculture, made a tour to Taveuni and Lau, primarily to investigate the result of two liberations of *Apanteles tirathabæ* against the spike- or spathe-borer (*Tirathaba trichogramma*) and also to study the leaf-miner (*Promecotheca reichei*).

*Tirathaba trichogramma*, Meyr.—Two colonies of the Javanese Braconid *Apantelas tirathabæ* were liberated at Mua, Taveuni, by Mr. T. H. C. Taylor in 1930. The first, at the end of April, consisted of 65 males and 100 females, and the second, in mid-November, of 50 of each sex. The site chosen was a block of Malayan Dwarfs planted at 15 and 20 feet quincunx-wise. During March, 1931, the writer collected several hundred Tirathaba larvæ from trees near the original liberation and up to a distance of a quarter of a mile, including several normal tall coconut trees. Young larvæ in the first and second instars, which are the stages parasitised by the Apanteles, were reared during the following week, while a number of third and fourth instars were preserved in chloral hydrate for subsequent dissections to find the internal parasite. All the young larvæ were reared through to moths, while no parasites were found on dissection.

The explanation of the non-recovery of the parasite may be due to unfavourable weather killing off the colonies which were rather small in each case (165 and 100) or, more probably, they may have spread so widely over a large area of the island that they are present in negligible numbers near the original site.

This apparent failure of Apanteles in Taveuni contrasts with its spread in the Suva district where there has been a noticeable reduction in the numbers of Tirathaba larvæ per spathe between the beginning of January and early March.

At Vuna and other districts in the south of Taveuni there were signs of an appreciable nut-fall at the end of April but no insect was incriminated.

*Promecotheca reichei*, Baly, (the Coconut Leaf-miner).—Statements of the damage done by this Hispid are still often inaccurate. Thus Maulik (1) states that the larvæ live in the folds of the unopened tender leaf-buds, whereas it is not until the leaves have opened that the eggs are laid and then they do not hatch for another two and a half weeks after this. Although indigenous to Fiji this beetle is rather scarce west of Taveuni and is normally a pest only in the Lau group, where the weather is very dry. The damage is two-fold, consisting of fine lines gnawed by the adult on the undersides of the tips of the distal leaflets, and larval mines, which may be seven inches in length, between the epidermes.

Before going to Lau the writer was most generously allowed to see an unpublished paper by Mr. T. H. C. Taylor who studied this insect for six months on Vanua Balavu. The present writer was only able to visit one estate, namely, on Munia, but unfortunately the beetles were just starting to oviposit so that there were no larvæ present during the visit. The beetle is most serious after a hurricane when the leaves have already suffered badly from wind damage. It is estimated to cause a loss of from 25 to 33⅓ per cent of the crop by weakening the trees.

Both the egg and larvæ are parasitised, the former by a Chalcid (*Chætostrictia*) and the latter by an external Elasmus, which in turn has a hyperparasitic Eulophid (*Tetrastichus sp*). The percentage parasitism of the larvæ in the January outbreak was about 15 at Munia, but no record could be obtained of the amount of secondary parasitism.

The most serious damage by the beetle is to the third and fourth youngest open leaves, the tips of the terminal pinnæ being especially eaten, giving a silver-grey colour to the leaves which is very characteristic. The beetle confines itself to a group of trees till these are badly injured, when it flies away to start another localised infestation. It is interesting to note that on one occasion an egg was found on the shiny dorsal surface of the leaf instead of as usual on the rougher lower side. It was seen that the damage had always spread from some site on the coast and the explanation seems to be the same as that advanced by Jepson (2) for Levuana, viz., that the coconut leaf-baskets consisting of leaves with some live pupæ in the mines were carried inwards from landing places by the natives.

Undoubtedly the chief controlling factor of this pest is not insect parasites but an abundant rainfall, as it is only in the very dry districts that it is of economic importance. In Taveuni this beetle occasionally does harm, but nothing comparable with that done in Lau. The rainfall for these two places during the visit was:—

| | *Mua, Taveuni.* *Inches.* | *Munia, Lau.* *Inches.* |
|---|---|---|
| December, 1929 .. | 8·52 | 0·4 |
| January, 1930.. .. | 12·05 | 8·1 |
| February, 1930 .. | 28·14 | 12·3 |
| March, 1930 .. .. | 9·1 | 5·9 |

Unfortunately the parasites are very susceptible to rain, thus nearly 37 per cent. of the *Elasmus* were found drowned in the mines at Mua. Another factor which favours the pest is wide planting of trees, as the beetle prefers sunlight and clear space rather than shade and crowding. Hence, one finds that European estates with their 30 foot planting suffer more than the overcrowded native holdings. The problem of the outbreaks is still unsettled.

For any introduced insect to establish control over *Promecotheca reichei* in Fiji it must be able to withstand drought conditions and be sufficiently oligophagous to survive between the outbreaks of the beetle.

A stick-insect (*Græffea crouani*) (2) called " mimimata " by the natives causes severe damage to the leaves, which are so eaten as to leave a deeply notched margin, or even only the midrib. This Phasmid is nocturnal, being found by day resting in the folded leaflets of the coconut trees. The female, which measures 11 cm., exclusive of the antennæ and gonapophyses, carries the male which is 8 to 9 cm. long. The resting position of both sexes is with the first pair of legs extended more or less parallel with the body. A white fluid with an unpleasant odour is ejected backwards from a pair of prothoracic tubercles when the insect is disturbed.

The egg, which measures 6 mm. in length, 2·75 mm. in width and 2 mm. in thickness, is light brown to chocolate in colour and deeply and irregularly pitted. It has an obliquely placed mammiform lid, a crater-like hilum on one side and a keel on the opposite side, the whole, as is usual in this family, simulating a seed in appearance. The incubation period is three months.

This is often locally a very serious pest. Jepson (3) writing in 1911 states that it does considerably more damage in some places than *Levuana* which was then of paramount importance. It is found also in Samoa, and was taken by Simmonds (4) in Wallis Island and Futuna, though here there may be a different species as the synonymy is still very vague, *Lopaphus cocophagus* and *Græffea cocophaga* being also used.

It was noticed in Taveuni that the insect was most abundant where there was long grass, especially buffalo grass (*Stenataphrum americanum* (*secundatum*) ) at the foot of the trees.

Grease-banding of the trunks to prevent the ascent of apterous females and nymphs, and smoking by fires lit under the trees are suggested methods of control. The introduced Australian magpie (*Gymnorhina*) and the Indian mynah (*Acridotheres tristis*) are said to be very useful in Taveuni as controlling agencies. The removal of tall grass from the plantations is to be recommended and would expose the eggs, which are showered down from the trees, to ant attack.

*Blow-flies.*—*Chrysomyia* (*Calliphora*) *rufifacies* and *C. megacephala* are the two blow-flies which do most harm in Fiji. On one estate in Taveuni where these flies were serious it was found that kerosene rubbed into the affected parts after shearing around the area killed the maggots and pupæ, though it caused a sore.

*Rats.*—Nearly all planters seem agreed that rats, and not fruit-bats (flying foxes), are the only mamalian pests. The bats (*Pteropidæ*) were seen to be feeding on male flowers which often fell down in a shower, but no damage to female nuts was noticed. Rats, *Epimys* (*Mus*) *rattus alexandrinus* and *M. norvegicus*, on the contrary may be very serious and breed in the tree-tops—one tree may sustain quite a number. In Taveuni many three-quarters grown nuts were found on the ground with rodent tooth-marks. Taylor (5) has shown that trees near a permanent supply of water do not suffer so much, pointing to lack of moisture as the main reason for the damage.

*Pigeons.*—These birds spread both *Clidemia hirta* and *Lantana* seed by means of their droppings, their crops are often crammed with both kinds of seeds.

*Clidemia hirta.*—Around Levuka this weed was noticed early in March to be very robust and thrifty. No liberation of the West Indian *Liothrips urichi* has been made on Ovalau. In Taveuni one colony has spread nearly a quarter of a mile from the original site, the insects were well established and ovipositing and the plants were wilted. On the same estate, and only a mile or two away, another colony liberated at the same time was not recovered at all. The interval between liberation and the visit was six months—September, 1930, to March, 1931. Both sites were on fairly high ground, but where the parasite was recovered there was a continous windbreak of trees. At Quacavula and Ura no traces of the insect were found. On several estates in Taveuni, Mauritius bean (*Stizolobium aterrimum*) and *Dolichos hosei* were being used with some success as smother-crops against this weed.

*Psidium guayava* (guava).—This has already become so serious in Taveuni that certain blocks of coconut land have had to be abandoned before it. On one estate alone more than 1,000 acres have been thus sacrificed. This plant is worse where the soil is friable than where it is clayey. Sodium chlorate spraying is considered fairly satisfactory if repeated after the shoots re-appear, but any pieces of roots which are left after attempts at eradication by digging are certain to grow up.

*Lantana crocea* and *Lantana camara*.—These verbenaceous weeds were seen to be very abundant at Ura, and generally along the south-west coast of Taveuni. Despite a temporary check from the Mexican Tingæid (*Teleonemia lantanœ*) introduced from Hawaii in 1928 this weed has sprung up again and was very dense and seemed to be spreading.

*Stachytarpheta dichotoma* (blue rat-tail).—This plant seems present everywhere throughout the Group and was growing luxuriantly at Vanua Balavu in Lau. In several instances it had passed from the herb to the shrub with a stem 1½ inch in diameter. White flowers in place of the normal blue were occasionally seen. Here again, an attempt to introduce parasites from South America would be worth a trial, perhaps concurrently with work on Psidium.

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## * POSSIBILITIES OF THE COLONIAL CANNING INDUSTRY.

By Sir Edgar Jones, K.B.E., Chairman of the Empire Canning Council.

(An intentionally provocative article, urging in particular the necessity for capital development of Colonial canning to compete in World markets, a field of vast potentialities.)

Englishmen have not been successful in the industry of agriculture at home in Great Britain. They have failed to apply modern improvements, organisation, and mechanisation to the oldest of industires. The lamentable conditions that have resulted in agriculture have had personal consequences; the young men of brains and character have entirely deserted agriculture and have turned for fame and fortune to other industries. In these, there is an atmosphere of enterprise, activity and progress: there are institutes and clubs of mining, marine, electrical and wireless engineers, but where are the institutes and clubs of agricultural engineers ?

In the more academic science of soils and products there are institutions and students whose research knowledge is the finest in the world. But modern organisation and engineering development in agriculture are lacking in Great Britain.

### THE CANNING INDUSTRY ABROAD.

In America and Japan, and more recently, in the Dominions, the canning industry has been found to have as remarkable an effect on the mechanisation of agriculture as the motor car has had upon transport. The enormous agricultural production of certain localities in America, otherwise similar in condition to rural England, has been created by the machinery of canning. What the mechanisation of the canning industry can do has been more dramatically exemplified by developments in Japan than those of almost any other country.

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* From *The Crown Colonist*, April, 1931.

In America, before the war, the production of tinplates was about the same as the British production, but to-day the American production is double the British production. In 1913 about 700,000 tons of tinplates were consumed in the United States. To-day that consumption is around 1,400,000 tons. About 76 per cent. of the tinplates used in the United States is used for canning foodstuffs. It is estimated that the output of canned foodstuffs in America is now worth over £200,000,000 annually.

Canada, Australia, South Africa and New Zealand have made substantial progress in the canning industry, and the indications are that there will be a large expansion of canning in those Dominions in the future.

It was owing to the failure to understand the possibilities of a canning industry and to apply this modern mechanisation to agriculture in England that plant and machines for factories were not originally manufactured in this country, and the production of cans was inadequate and inefficient. In the past four years, this has been changed with an astonishing measure of success and the mechanisation methods of the canning industry have in England been applied to fruits, vegetables, soups, mixed foods, fish and other products. As a result, substantial engineering firms are now making cans efficiently, some are manufacturing plant for making cans, and others are manufacturing plant and equipment for the canning factories.

At long last, Englishmen are awakening to the practical utility of this modern industry for the revival of agriculture at home and for its development throughout the Empire. Young men seeking a career will now include this industry as one worthy of their best efforts.

Up to the present Englishmen have been lacking in leadership in this direction in the Colonies. Americans have developed a great pineapple canning industry in American Colonies, and the Chinese have developed a similar industry in certain British Colonies, but the initiation, stimulation, and organisation of a canning industry have not been taken up by Englishmen, and they have not organised native capital and enterprise in that direction.

If the four Dominions and Great Britain are excluded, it is found that the total consumption of tinplates in the canning of food-stuffs in India and the Colonies is only about 20,000 tons per annum against the America consumption of 1,400,000 tons.

The Colonies and India have, comparatively speaking, no substantial canning industry. Those countries, however, have a population of 380,000,000 consumers, and if we add the other native populations adjoining the various parts of that Empire a total of over 800,000,000 is arrived at. This vast body of consumers eat food-stuffs like the consumers in other parts of the world. Amongst them, as in other parts of the world, there are similar problems such as gluts, shortages, seasonal crops, and marketing difficulties. These consumers also require special food-stuffs different from European food-stuffs. Very little has been done as yet to utilise the economic efficiency of the canning industry for the preservation and distribution of the special foods of this vast population, as has been done for the food-stuffs of the American and European populations.

A new era is beginning, however, and Englishmen to whom the populations of the various Colonies look for leadership will, we may hope, be henceforward starting a new mechanisation of agricultural production throughout the Empire.

### POSSIBILITIES IN THE COLONIES.

There are enormous possibilities, but it is very important that developments should begin with a right understanding and on sound lines. It must always be remembered that the main function of a canning industry is to provide and preserve products for the local population. There is a great need for milk products, fish products, and poultry or meat products with beans or other vegetables amongst the native populations. In this direction, in many parts of the Empire, there is unlimited scope for the future. Factories for such local purposes do not require a large amount of capital or elaborate plant. The essential machinery for a cannery which would provide for the most modern treatments need not cost more than about £400 for a small commercial unit, and the machinery for making cans for such a unit need not cost more than about £300.

In the past, when British territories have started a canning industry, they have had to go to America for the machinery for canning and for the making of cans. They can now, for the first time, come to England for technical advice and for plant and machinery. Technical information as to the treatment of products is easily available and classes of instruction are open in England for students from the Empire. Further information can be obtained from the Empire Canning Council, 12 Whitehall, S.W.1.

At first we shall be met with statements that there is nothing useful to can for local population. Such statements can now be declared to be wrong, and if the Agricultural Departments of every Colony will make practical trials, initial assumptions of this kind will soon be disproved.

### CANNING FOR THE WORLD MARKET.

There are no serious marketing problems about this side of the canning industry; when it comes to the other side, namely, the mass production of special products in a Colony for sale in England, America and Europe, then the conditions are different. There must be substantial capital and organisation to break through the competition in the organised world markets. This is where the help and leadership of Englishmen must be substantial in order successfully to place on the market such canned goods as peaches, tomatoes, pineapples and mangos, and this will require powerful commercial resources. Great things could be done in this direction if large corporations were available in England to organise the marketing end of a chain of factories in the Colonies. What Cadbury has done for cocoa, Lipton for tea, Lever for palm oil and the margarine firms for nuts, can be done for canned products of the Empire on a great and successful scale.

Even for the small producers in the Colonies, however, there are at the moment opportunities in the world markets. Canned grapefruit, figs, and dates in syrup are new to the world markets, and they are yet occupied by the American producers. There is a big opportunity for the Colonies in these newer canned products. If they delay even two years, they will find that once again they have neglected a splendid opportunity.

The importance of this matter to British and Colonial trade development cannot be over-estimated. Details of what has been done in foreign countries, and of what may be done throughout the Colonies are given in a paper read before the Royal Society of Arts in April, 1930, to which readers of this article are referred for further information.

## STEAM-DRIED COPRA.

INFORMATION regarding a special shipment of copra prepared at Mua Estate, Taveuni, and dried in the new steam drier there, has been courteously furnished by the Coconut Planters' Union Limited. The shipment was handled in London by Messrs. L. M. Fischel & Co. Ltd., and specially reported upon by Loders & Nucoline Limited, one of the firms of the Unilever group. The report on the copra is as follows:—

> "RMA 194 FMS PLANTATION FIJI SOUTH SEA, 171 BAGS MARK MUA/CPU EX S.S. 'SIERRA.'
>
> We give below the report on this parcel of copra as requested in your letter of 5th inst.
>
> Good white copra above usual standard, appearance equal to high grade, some pieces rather thin. Some green mould indicating excess moisture.
>
> Bags packed very tight, giving approximately 180 ℔ weight compared with usual 154 ℔/160 ℔. There was no evidence of oil having been pressed on to bags due to tight packing.
>
> The analysis as compared with average of reference samples of FMS Plantation Fiji is:—

| | 171 *bags.*<br>*per cent.* | *Ref. samples.*<br>*per cent.* |
|---|---|---|
| Oil content .. .. | 66·0 | 68·4 |
| Water .. .. .. | 4·5 | 3·1 |
| FFA .. .. .. | 1·2 | 4·5 |

> We class this copra in dust Group A and colour Group A.
>
> We wish to draw attention to the low oil content."

Messrs. Fischel & Co. Ltd. comment on the consignment in these terms:

> "You will see that the copra marked MUA/CPU 171 bags Fiji copra, is really a very good analysis; the f.f.a. is low, while the oil contents of 66 per cent. is quite good, although the Unilever draw our attention to the fact that the contents is lower than usual. We have had a small open sample of this copra in the office and must say it is really very nice quality and should command a small premium over usual Plantation, although this is not easy to obtain."

## THE IMPORTANCE OF GRASS.

(From "Increased Butter-fat Production" by H. W. HERN
in *The New Zealand Dairyman*, Feb. 20, 1931.)

THE grass pastures are the indispensable crop of the farm. The grass under our feet is the natural forage, the healthiest and most nutritious food for milking cows. If there was throughout the milking season an abundance of rich, succulent, short and growing grass, little else would be needed to help and maintain the increase of milk and butter-fat. The growing of supplementary forage and fodder crops to provide adequate supplementary feed for the herd has been strongly advocated by the writer; but it must be remembered that these crops are intended only to supplement, not to take the place of, our pastures. The grass of a carefully-managed pasture produces more milk than comes from any other source of food grown on the farm. The only profitable system of dairying is to maintain the pastures in the best and most productive conditions possible, and by wise management to utilise the grass so obtained to the best possible advantage. Permanent pastures are the dominant feature of the agriculture of this country, and the character and use made of the pastures determines the stock-carrying capacity of the land. The improvement of our pastures is a matter of vital importance. Yet an inspection of the permanent pastures shows, in practice and in fact, that the majority of our grass lands are not being properly managed, are not producing the grasses and clovers that they are capable of growing, and all too frequently they contain a large percentage of inferior grasses and useless weeds.

### PASTURE MANAGEMENT.

The management of our grass lands is concerned firstly, with increasing the total production of the pasture, as far as is economically possible, with plants of first-class feeding value; and, secondly, in the utilisation of this maximum grass production to the fullest extent. It is essential that feeding should be continuous, spring, summer, autumn, and winter. The winter feeding of cows plays a very important part in production. Mixed pastures are better than pure ones, where they can be successfully maintained, because they provide a mixed fodder with a varied palatibility of feed, which is preferable to a pure one for cows. The various grasses and clovers also vary in their rate of growth during different periods of the year, and as the larger number of our permanent pastures are more or less continuously grazed, it follows that continuous grazing can be satisfactorily achieved only on land where the various grasses and plants constituting the permanent pasture yield their maximum growth at various periods throughout the year. Although the laying down, preservation and management of our permanent pastures is a matter of vital importance to the dairy farmer and to the Dominion, it is a regrettable fact that the majority of our pastures are not really productive, nor are their contents anything approaching plants only of the highest feeding value. The following are some of the factors of pasture mis-management urgently needing attention:—Unsuitable mixtures sown in the first instance, neglect of necessary care in seeding, the predominance of short-living grasses in the place of more permanent ones, inferior grasses and weeds, want of proper drainage, absence of lime, want of proper management with regard to stocking, allowing the grass to get away beyond the proper length of maximum feed value, want of utilisation of excess growth as silage during period of abundance, want of manuring with the soil deficient in fertility, and top-dressing with fertilisers at the wrong time or so as not to extend the period of pasture growth during periods of shortness of growth.

Grass is now looked upon as a crop, which should not be allowed to grow beyond a height of from four to five inches, when it is rapidly fed down and then spelled to grow again. This pre-supposes three main factors of pasture management—closer subdivision, regulated stocking, and suitable top-dressing. As the majority of our dairy farms are not yet sufficiently subdivided to allow of the complete control of the pasture growth during the summer period of abundance by means of grazing, all surplus growth should be mown and conserved by ensilage for use in periods of pasture shortness. What is required in our pastures is not an abundance of grass growth, but a continuous growth of young leafy grass. The feeding value of grass has now been shown to rapidly lessen as it gets older, being long past its best at the flowering stage and containing half as much protein as it did when young and a large amount of indigestible matter. Grass in the young leafy stage is as rich as clovers in protein and is almost completely digestible by the animal. The aim of the dairy farmer should be to control the pasture growth by careful rotational grazing and management, so that the grass is kept short and succulent, and the pastures in the best and most profitable condition of herbage in continuous growth in the young leaf stage. A more general adoption of intensive grass management cannot but result in a material increase in butter-fat production.

### EFFECT OF HIGH LAND VALUES.

An important factor which has contributed to retard the better improvement of our pasture lands is the fact that too many farmers, since the war period, have shifted from one farm to another. A good many landowners were more speculators than real farmers, being more interested in the profit likely to be made on resale of the land than on the permanent improvement of their pastures and the maintenance of fertility of their land. As long as this state of affairs continued, the personal interest and enthusiasm necessary for success was lacking. The bad times, with consequent re-adjustment of land values, through which we are passing, will check this tendency It should make our farming more permanent, with the return to be obtained from the soil, on the re-establishment of the dairying industry on paying and profitable lines, of the first importance.

### THE NEED FOR SUPPLEMENTARY FEEDING.

The critical pasture periods and the need for adequate supplementary feeding to maintain the maximum milk production was dealt with fully in the article entitled " Supplementary Feeding," published in the *Dairyman* for July, 1930. Although the grass is the natural food of the cows, it is becoming more evident that our dairy farmers have in the past depended too much on the grass alone, and that the feed produced by our permanent pastures should be supplemented with hay and roots in winter, and silage or grass forages in the summer and autumn, if we are to obtain the maximum milk production of which our cows are capable. It is only by making suitable preparation that a supply of feed will be available in the days of scarcity, when a sufficiency of feed is of essential importance in successful dairying.

### THE IMPORTANCE OF TOP-DRESSING.

On all our dairying grass lands the most important means of increasing the production of the pastures is by adequate and suitable top-dressing. In dairying this is a most important phase of farm management, and the annual application of fertilisers should be looked upon as important as the daily milking of the cows. The outstanding feature of the manurial requirements of the soils of New Zealand is the major importance of phosphatic fertilisers. On dairying pastures lime also is required. In addition to improving the actual yield, phosphatic manures assist the growth of first-class grasses, and by improving the quality of the herbage play a most important part in the health, constitution and vigour of the stock which graze on pastures treated with lime and phosphoric acid.

The modern tendency in top-dressing pasture lands is not to apply fertilisers to increase the grass growth during the period of normal maximum growth, but rather so as to stimulate growth in the early spring, autumn, and winter. The object of top-dressing in future will be to make the pasture growth as continuous and even as possible throughout the year. It is not in times of pasture abundance that additional growth is required, but it is in times of lessened pasture production that increased herbage is of the greatest value.

### THE VALUE OF BREEDING.

Breeding is a most important means of increasing the butter-fat output of our cows. Herd-testing should be universally adopted, and at the same time farmers should realise the necessity of having pure-bred bulls at the head of their herds. The practice of keeping any kind of bull, so that the cows were put in calf, has been far too common in this country. This was particularly noticeable in the case of too high priced dairying land, where a farmer was compelled to over-stock with milking cows, so that he could not keep any heifers, and the calves were killed. If all the calves were killed it would not have mattered very much, but unfortunately many farmers kept what they regarded as their best calves, knowing full well that they were the progeny of a scrub bull. This practice has perpetuated one of the troubles of our dairying industry: the low butter-fat production of many of our milking cows.

The important thing in working up a good herd is to have a good foundation. The breeder should first choose his breed, and having selected the type he wants, keep to it. A start can be made in a small way, with a good sire and a few cows. It is much better to have a few cows of good quality than a large number of average nondescript type. Line breeding is the most successful way to establish continuity of type. It is not necessary to sacrifice type for production, and to mate the progeny of a cow of record butter-fat production with a herd of perdigee line-bred cows more often than not leads to disappointment. Many of the best performers in the Dominion semi-official test are typical of their breed and line-bred. In the Island of Jersey, importation of foreign cattle has always been forbidden, and the Jersey cattle have been bred from a type and butter-fat standpoint. By line-breeding the pedigree of a certain strain is followed right through, with preservation of type. Although it is true that half the breed goes down the throat, it is equally true to say that the bull is half the herd. In any effort to assist the re-establishment of the dairying industry by increasing the production of butter-fat, the permanent factor of improvement is a herd of higher-producing cows.

## LIME IN PASTURES.

(From *The New Zealand Dairyman*, Jan. 20, 1931.)

DR. J. B. Orr, of the Rowett Institute, dealing with the importance of minerals in the feeding of dairy cows, says:—A cow giving four gallons of milk per day secretes daily in the milk 1·0 oz. calcium, 1·3 oz. phosphorus, 0·4 oz. sodium and 0·64 oz. chlorine. These are taken from the living tissues of the animal, and unless she can absorb from the intestine sufficient to replace this loss, the tissues become depleted. In most heavy milking cows there is, during lactation, a progressive depletion of the skeleton. It has been estimated that a cow may lose as much as 20 per cent. of the mineral matter of the skeleton during a lactation period. The writer has suggested elsewhere that the depletion of the tissues of heavy milking cows may be the cause not only of decreased milk yield in subsequent lactations, but of difficulties in breeding, and an increased susceptibility to disease.

The element which presents the most difficult problem is calcium. The fodder fed, especially if it includes good hay, will contain more calcium than is secreted in the milk. Even if an abundance of calcium be provided in the food, however, there is difficulty in getting a sufficient amount absorbed from the intestine. The calcium in green food is more easily assimilated than the calcium in concentrates. It is also better assimilated from well got hay which has been little exposed to the elements after cutting than from hay which has been badly weathered.

The statements made by this authority suggest that the addition of lime to the pasture and keeping up a sufficient supply of lime at all times in the soil would increase the supply of lime in the grass and particularly in the clovers and trefoils and this would not only tend to increase the milk yield of the herd, but would be largely instrumental in preventing diseases and disorders in dairy cows and would play an important part in developing the frame of the calf. The presence of rock salt on pastures where the cows can lick it when so inclined is also valuable in maintaining the health of cows.

## THE COCONUT MOTH IN FIJI.

A RECORD of the work undertaken by the Coconut Committee for the control of the Levuana Moth of coconuts in Fiji, has been published under the above title by the Imperial Bureau of Entomology. The account of this most interesting and successful campaign for the control of one of the most serious pests of coconuts in the Fiji Group has been compiled by Dr. J. D. Tothill, T. H. C. Taylor and R. W. Paine. The book (Crown quarto) comprises 265 pages of letter-press and 24 plates, the originals of many of which were prepared by H. W. Simmonds.

The record of this highly organised and relentless campaign against an enemy which bade fair to make the production of copra in Fiji unprofitable is one of absorbing interest, particularly to workers in other territories who are faced with problems concerning the biological control of serious pests.

The contents include an introduction and a historical account of previous work, followed by a general account of the campaign instituted in January, 1925. The Levuana Moth is fully described, as is also the Tachinid Fly, *Ptychomyia remota*, which was successfully introduced, bred and distributed locally. The report is supported by descriptions of allied Zygaenids and notes on their natural control, together with an account of the predacious beetle, *Callimerus arcufer*. The book is primarily one which will interest students of economic entomology and it should form a valuable acquisition to the libraries of Research Institutions which are concerned with entomology.

Copies may be obtained either from the Department of Agriculture, Fiji, or from the Imperial Bureau of Entomology, Queen's Gate, London, S.W.7, at a cost of £1 11s. 6d.

The publication was authorised by the Coconut Committee of Fiji, who bore all expenses connected therewith, and forms a valuable record of protracted investigations carried out under their direction.

## SEEDS FOR DISTRIBUTION.

THE following seeds are available for distribution on application to the Department of Agriculture, Suva; or the Government Experimental Farms at Navuso, near Suva, and at Sigatoka:—

(1) Paddy Rice, variety "Sonacalif." A quick growing, early rice, seed of which can be obtained in limited quantities at 2s. 6d. per benzine tin, containing about 28 lb.

(2) Mahogany tree seeds from the West Indies:—
  (*a*) *Swietenia mahogani* (West Indies mahogany).
  (*b*) *Swietenia macrophylla* (British Honduras mahogany).

These can be obtained free of charge.

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## INTRODUCTION.

THE records of experimental work on the improvement of methods of preparation of copra are scattered through a wide range ot publications. The present account deals with investigations primarily directed to the study of possible simple methods for adoption by small producers in the Colony of Fiji, having for their object the prevention of rapid deterioration of copra by mould attack.

The Coconut Committee allocated funds for the construction of the sulphuring chamber which was designed by Mr. H. R. Surridge, who carried through the experimental part of the work. Mr. W. J. Blackie conducted the chemical examinations of the material in Fiji, and together these officers have presented an interesting paper which should prove of value not only to Fiji but to workers in other places who are confronted with similar problems.

The Imperial Institute, to whom samples of the copra prepared by Mr. Surridge were referred for further examination, have furnished a comprehensive and valuable report, a summary of which is published. The co-operation and assistance accorded by the Director of the Imperial Institute and his staff are gratefully acknowledged.

A. C. BARNES,
Director of Agriculture.

## THE IMPROVEMENT OF FIJI COPRA.

### SECTION I—A.

By H. R. Surridge, A.R.C.Sc. (I.), Agronomist, Coconut Committee.

Owing to the high proportion of very low-grade copra produced in and exported from these islands, Fiji copra has been classified as " low grade " on European and other markets. This low-grade copra is mainly produced by the native who employs primitive methods and lacks organisation and the economic urge to produce a first-grade product. His plantations consist invariably of isolated blocks of coconuts, of varying sizes, in all manner of locations, the larger plantations being on the coast line, the smaller blocks scattered along river banks and hill sides. Until recently these plantations had received no cultivation, but under the instruction and direction of the Inspectors of the Coconut Committee this matter has been and is receiving attention. The collection of nuts is spasmodic, depending, if anything, more on the desire for luxuries rather than the want of necessities. When the nuts are collected they are usually old and many have germinated, so that under the best conditions a poor quality copra would be produced, but to the low-grade of nuts used must be added the methods adopted in curing the meat. The native treats his green copra in one of three ways:—

(1) without husking, he splits the nut and lays it open on the ground without any protection from the weather, &c., for the preliminary drying, prior to extraction of the green meat from the shell;

(2) as in (1), except that instead of laying the nut on the ground the halved nut is hung up by the fibre on lines between coconut trees. Under favourable weather conditions a comparatively good quality copra results, but during rainy weather such copra is usually left unprotected with the result that it rapidly moulds and deteriorates;

(3) after splitting the nut the green meat is cut out and placed on reed vatas (shelves) to dry in the sun. Given good dry weather some very good copra is produced, but during rainy weather the copra is either left uncovered or gathered into a heap and any covering material handy, *e.g.*, sacks, corrugated iron, &c., is thrown over it and the whole left indefinitely. Under such conditions moulds and insects soon attack the copra and reduce it to the lowest grade.

The marketing of this product raises other questions and problems, three points of which are here briefly discussed:—

(1) it is customary for some natives to cut green copra, bag it and sell to a dealer. Subsequent curing does not always obviate the result of sweating due to the bagging of the undried material, because many dealers have not the facilities for quick and efficient drying;

(2) the native with " get rich quick " ideas will mix green copra with cured copra with dire results to both. His idea is to make up his weight irrespective of the quality of his produce;

(3) adulteration with foreign matter.

Nos. (1) and (2) still obtain throughout many parts of these islands, but No. (3) is not favoured by the native as much as hitherto. These are some of the factors which have caused Fiji copra to be placed on such a low grade, so much so, that the progressive planter who is producing a first-grade article finds great difficulty in securing adequate recognition of his superior grade copra owing to the generally poor quality of Fiji copra.

*Sulphuring.*—In the effort to improve the quality of Fiji copra in general and the native copra in particular, the question of the treatment of the green meat by sulphur fumes ($SO_2$) has been considered. Some progressive planters sulphur their copra with beneficial results. In other countries sulphuring (2) has been used with good results for some years, and it was considered therefore that provided a suitable equipment could be designed to meet local conditions, the same method might, with advantage, be applied to native copra here in Fiji. For this purpose a portable sulphuring chamber, having a capacity of 1,000–1,500 nuts, the equivalent of about a quarter of a ton of dry copra, was designed Its construction was such that it could be dismantled and assembled quickly, was fool-proof, could be made locally, and could be transported by hand labour from place to place.

It might here be mentioned that the native is in most districts familiar with the use of a sulphuring chamber for medical purposes, and it was considered that with such knowledge it should be an easy matter for him to operate the copra sulphuring chamber.

Having designed such a chamber, it was essential that it should be thoroughly tested, and, in so doing, to obtain all possible and practical knowledge of the resulting product. For this purpose a series of copra sulphuring experiments were designed to demonstrate the effectiveness or otherwise of the chamber for the purpose for which it was to be used in the field, and also the quality of the sulphured copra under varying conditions of treatment. The following paper gives details of the sulphur chamber and the experiments carried out with it.

### THE SULPHURING CHAMBER.

The plans and specifications appended, give a good idea of the type of structure used, its portability and its capacity. The chamber consists of a large wooden oblong box of the following dimensions:—

| | |
|---|---|
| Chamber (internal measurements) . | 6′ 6″ by 4′ 6″ by 3′ 4″ |
| Sides .. .. .. .. .. | 6′ 6″ by 4′ 6″ each. |
| Ends .. .. .. .. .. | 4′ 6″ by 3′ 10″ each. |
| Roof .. .. .. .. .. | 6′ 8″ by 3′ 10″ |
| Trays . .. .. .. .. | 6′ 3″ by 3′ 3″ by 6″ each. |
| Brace . .. .. .. .. | 3′ 4″ by 2″ by 2″ |

*Sides.*—6″ by 1″ boards are used for the sides, held at the ends by 3″ by 2″ timbers and strengthened towards the centre by two 3″ by 1″ battens, 15″ apart; 2″ by 2″ timber runs the length of the top between the end 3″ by 2″ timbers. This carries the three bolt holes for attaching the roof as well as strengthening the length of each side. At 1′ from the bottom, on the inside, a 3″ by 1″ batten running the whole length of each side, is fixed. These battens constitute the only set of runners carrying the trays of copra. At one end, about 3″ below these runners, a slotted wooden bracket is fixed to take the tongued end of the brace. This brace prevents the sides from spreading during loading and unloading operations, and is easily removable when it is required to place the sulphur burner in position at the bottom of the chamber. It should, however, be replaced after insertion of the burner and prior to the sealing of the chamber. Bolt holes must be drilled through the 3″ by 2″ timbers at each end and the 2″ by 2″ timber at the top, as indicated on the plan.

*Ends.*—The ends consist also of 6″ by 1″ boards held together on the short ends by 3″ by 1″ battens. Bolt holes are drilled to correspond in position and size with the three holes drilled in the 3" by 2" timbers of the sides, as shown on the plan.

*Roof.*—The timber used for the roof consists of 6" by 1" boards, 3" by 2" timbers and 2" by 1" battens. The structure overlaps the walls to secure an efficient gas-proof box as well as for convenience of handling. Two 3" by 2" timbers are used to hold the ends of the 6" by 1" boards, and one at the centre for strength. Between these timbers and at the sides, 2" by 1" battens are fixed to assist in the alignment of the sides, to improve the gas holding qualities of the chamber and to strengthen. Three bolt holes are required on each side in the positions indicated on the plan and corresponding with the holes drilled in the side walls.

*Note.*—It is advisable to drill all holes about 1/16th of an inch larger than the size of the bolts to be used. This will facilitate their insertion and removal.

*Trays.*—The construction is simple and strong with a capacity of 150–200 nuts, without overloading. The trays are made of 2" by 1" battens with 3" by 1" diagonals, slotted at the centre and where they meet the cross struts, thus giving a very rigid frame. The bottoms are covered inside with ½" mesh wire netting. The sides and ends consist of a double length of batten separated by an air space of 1", giving a depth of 5" inside and 6" outside. These details apply to six out of the seven trays for this chamber. The seventh tray differs only in depth, being 1" shallower than the others. This is because the cross timbers of the roof do not allow clearance for the seven trays of a depth of 6". The wire bottom and the grid sides of these trays allow for free circulation of the gas throughout the chamber. On each of the sides and at the centre of the sides, wooden runners with bevelled edges are fixed to enable one tray to slide easily over the tray underneath. It is advisable to cut the four pieces of wood supporting the sides of the trays ⅛" short since, owing to differences in shrinkage, particularly of new wood, these short pieces are apt to protrude slightly above the long battens forming the sides and interfere with the free running of one tray upon another. Screws should be used in preference to nails wherever possible, particularly in the construction of the trays. On completion of the chamber and trays a coating of creosote is recommended. Bolts with "butterfly" nuts are required. Such nuts facilitate assembling and dismantling, and are not easily lost. It will be noted that the length and breadth of the trays are ⅛" short of the internal dimensions of the chamber thus allowing for a certain amount of play and increasing the facility in loading, gas circulation and sealing, an important factor in wet weather.

*Method of assembling.*—Place the two sides opposite and parallel to each other, sufficiently apart to fix the brace in position. Next take one of the ends of the chamber and bolt it to the sides at the end farthest from the brace. Now place the roof in position and bolt securely. The chamber is now ready for loading.

*Loading.*—Having filled a tray with freshly-cut copra place it on the runners and push it right home so that it fits just inside the chamber. Repeat with each tray, running the filled tray over the tray underneath, until the chamber is full.

*Sulphur charging and sealing.*—Remove the brace and place the sulphur burner with its charge freshly lit, as far under the bottom tray as the arm can reach. Replace the brace, bolt the door or end securely, and the chamber is now sealed for sulphuring the green copra. It will be found advantageous to earth up lightly around the bottom of the chamber to ensure a more perfect retention of the gas during the time the chamber is sealed, particularly if the floor is uneven.

*Sulphur burner.*—For the purpose of this sulphur chamber, a strong portable burner made out of materials usually obtainable from any storekeeper in these islands was used. It consisted of an enamelled fry-pan to which was fixed four stout wire legs to support, overhead, a large enamelled plate. The object of using enamelled-ware was to avoid the action of the fumes on iron-ware and so ensure long life to the burner. The height of the burner and cover was 9″, allowing a clearance of 3″ between the top of the burner (enamelled plate) and the bottom of the lowest tray. The plate is considerably larger than the fry-pan, the dimensions being: diameter of plate, 14″; of fry-pan, 9″. These dimensions secure efficient covering for the sulphur flames and thus eliminates risk of fire. The utensils used are not essential since benzine or kerosene tins could be adapted for the purpose, but such a burner as described is very strong, durable, easily handled, safe, and in the long run inexpensive.

*Effective sulphur burning.*—Many users of " flowers " of sulphur for fumigation purposes have experienced difficulty in securing complete combustion of the sulphur. During the course of these experiments similar difficulties were encountered, but were eventually overcome. It was found that as the charge of sulphur increased so an increasing proportion of unburnt sulphur remained in the pan. This as far as could be judged, was not due to lack of air. The first attempt to secure complete combustion was made with dried wood chips soaked in a 1 per cent. solution of potassium nitrate ($KNO_3$) and mixed with the " flowers " of sulphur. A slight improvement was noted. A similar trial, using potassium chlorate was made, with the same result. The suggestion was then made that a catalyst was probably required to assist the sulphur to burn. A small cast-iron grid was obtained and the sulphur placed on and around it. This was not successful.

Finally, the dried husk of a coconut was taken and some of the fibre teased out and laid on the fry-pan in a rough circle. A layer of the sulphur was placed on this, then alternate layers of fibre and sulphur, until the required amount of sulphur had been utilised. Two layers of each were found sufficient for eight ounces of sulphur. A match was then applied and it was noted that the fibre and sulphur burnt intermittently, slowly but surely, until all the sulphur was consumed, leaving just the charred framework of the fibre. In all burnings carried out in the manner just described, the result was always complete combustion of the sulphur. This represents a simple and effective method of burning sulphur on the plantation, since coconut husks are always obtainable, one husk being sufficient for several burnings. Experiment would indicate the amount required for the particular charge of sulphur being used. This method has since been tried out and adopted on a commercial scale with marked success, no difficulty being experienced in the burning of charges up to 5 ℔ of sulphur at a time, this amount being the maximum attempted.

## COPRA SULPHURING EXPERIMENTS.

To secure results which should be of the greatest service for the conditions obtaining in Fiji, the coconuts used in these experiments represented a fair sample of nuts such as would be used by the native for the production of his copra. The nuts were obtained from native plantations in the Lower Rewa district near Suva. About 8,000 of them were required to make one ton of copra, and they were gathered within a month of the hurricane which visited these islands in December, 1929. Native collection of nuts is, as already stated, spasmodic, hence the heavy proportion of old nuts that were present amongst those supplied for the making of copra in this experiment. It should be mentioned that in Fiji it is the custom to allow the nuts to fall naturally before making them into copra, while the practice in Ceylon, Malaya and other countries (10) is to cut down the nuts from the trees when ripe.

In experiments 1, 2 and 7, trays of copra made from germinated nuts were set aside for separate observation and chemical analysis, the object being to demonstrate the difference, if any, in the quality of copra made from ripe nuts as against that made by old or germinated nuts. The nuts for experiments 1 and 2 were husked and halved before sulphuring, 1,200 nuts being easily accommodated in the sulphur chamber when cut this way. For the remainder of the experiments the green copra was cut out plantation style, in smaller pieces, fingers, &c. By this method 1,500 nuts were easily accommodated for one sulphur burning. For the subsequent curing of the meat, after sulphuring, old banana packing tables were used on which, green copra was spread. These tables consist of heavy timber tops which did not allow of a free air circulation as in the case of the usual reeded vatas (shelves) commonly in use in these islands.

Further, the season of the year 1930 (January to March) during which these experiments were carried out was the wet or rainy season when drying conditions were not favourable to good copra curing. For this particular period there were 25 days of rain during January, 19 days in February, and 23 days in March, together with a humidity varying between 68 and 100 per cent. Under such circumstances the average time taken for curing was 14 days, the minimum being 9 days and the maximum 19 days. Under dry season conditions the time required in most parts of these islands for copra curing varies from 2½–5 days. It will be seen therefore that for the purpose of these experiments the weather conditions were such as to demonstrate effectively the utility or otherwise of the sulphuring of green copra for the improvement of the subsequent product by mould control, since the longer the time taken and the greater the humidity during the time of curing, represent factors favourable to mould and other growths which bring about serious deterioration in the quality of copra.

In designing these experiments it was the original intention to use varying quantities of sulphur for the same periods of time to discover the necessary charge of sulphur required and the length of time needed to seal the chamber to secure the efficient sulphuring of the green copra. The amounts of sulphur to be used were 4 oz., 8 oz. and 12 oz., sealing the chamber for periods of 3, 6. 9 and 12 hours for each charge of sulphur. In practice it was found that certain of the time periods could be dispensed with, primarily because the sulphur charge was not strong enough to last the time required.

The experiments conducted during this investigation resolve themselves into four series, the first three dealing with the sulphuring of green copra without previous treatment and the fourth dealing with the sulphuring of green copra after a preliminary treatment. While the former confirms previous knowledge as regards the value of sulphur fumes ($SO_2$) (12) as a preventative of mould growths on copra under reasonable conditions of storage and transport, the latter appears to open up possibilities of treatment for the further improvement of copra rendering it less liable to deterioration by either fungi or insects during drying and storage, and requires to be tried out on a commercial scale to demonstrate its utility. This is discussed later on in this paper. Notes on the condition of the copra at the time of bagging will be found tabulated at the end of each series of experiments.

*Series* 1.—Four ounces of " flowers " of sulphur were used for the charge in the two experiments comprising this series.

*Experiment* 1.—Twelve hundred coconuts were taken, husked and split in half, the halves still in the shell—a system in use in the Philippine Islands—were then loaded on to the trays and the whole run into the sulphur chamber. Four ounces of " flowers" of sulphur were put into the burner, carefully lit and, after removing the brace, placed as far as the arm could reach on the floor under the bottom tray. The brace was then replaced, the door bolted into position, and a thin heap of sand placed around the bottom of the chamber to prevent escape of the gas. This work was completed by 4.15 p.m. and six hours later (10.15 p.m.) the door was unbolted and removed and the trays left in the chamber overnight. As a result of this a certain amount of sweating took place. On the opening of the chamber a trace of sulphur fumes was noted, and the wet meat quickly gave an acid reaction to litmus paper. With reference to this latter note, green copra usually gives a slight acid reaction to litmus, so that the rapidity and definiteness of the reaction after sulphuring suggested that some of the sulphur dioxide had been absorbed by the moist copra. On the following day the copra was spread out on tables for sun-drying, as follows:—

(*a*) one tray was set aside for drying without protection from the weather and was left uncovered at night until drying was completed;
(*b*) one tray of this copra consisted of material cut out from germinated nuts. This was set aside for special observation and chemical analysis, otherwise treated as (*c*);
(*c*) the remainder was spread out on the tables for sun-drying and placed under cover at night and during rain until cured;
(*d*) as control copra for this and all other experiments described in this paper, 100 nuts were cut out according to the method adopted for the various experiments, and spread out on a table to sun-dry in the usual way, this copra *not* being sulphured but otherwise receiving the same protection as (*c*) above.

*Note.*—It often occurs amongst the natives that green copra is cut out and left either on the ground or on vatas without any protection from the weather. It was required to know therefore, what influence such treatment would have on the sulphured article, hence the reason for subjecting one tray of copra in the various experiments to similar conditions.

All copra was carefully raked over each morning after exposure to the sun for about one hour. The copra of this experiment (No. 1) took 12 days to cure, intermittent showers and high humidity delaying drying. Moulds (Penicillium and Aspergillus varieties) appeared on the third day of drying and continued to increase until the ninth day, the growths appearing more persistent and more freely on the sulphured sample as against the unsulphured or control sample. This copra was finally sampled and bagged on the twelfth day of drying.

*Experiment* 2.—This experiment as regards the sulphuring varied only from No. 1 in that the chamber was sealed for three hours. On opening there was a fairly strong smell of gas. The weather during the period of drying was similar to that of Experiment 1. After four days of sun-drying the moulds Penicillium and Aspergillus appeared and made rapid progress, due to the humid conditions prevailing. Drying was completed in 10 days, when the copra was duly sampled and bagged.

CONDITION OF THE COPRA ON BAGGING—SERIES 1.

| Expt. No. | Sulphured. | | Covered. (*c*) | Control (not sulphured) (*d*) |
|---|---|---|---|---|
| | Uncovered (*a*) | Germinated. (*b*) | | |
| 1 | Appearance fair, some moulds and brown discoloration.<br>Quality poor. | Appearance & colour fair. Some moulds & browning of the copra. Very thin and chippy.<br>Quality fair. | Appearance fair, rather better than control (*d*) although it had moulded freely.<br>Quality fair. | Appearance fair, moulded freely.<br>Quality fair. |
| 2 | Appearance bad, moulds very prevalent. This sample wass everely attacked by the copra beetle, (*Necrobia rufipes*) and ants.<br>Quality poor. | Appearance poor, moulds very prevalent.<br>Quality poor. | Appearance fair, moulds present & brown discoloration. Not so good as control (*d*) in appearance.<br>Quality fair. | Appearance fair, moulds present. This appears to be the best copra of this series.<br>Quality fair. |

In view of the results obtained with the sulphur charge used in these two experiments, particularly as regards the comparatively weak concentration of the sulphur dioxide gas on opening the chamber after three hours sealing and the mere trace found after six hours sealing, it was considered valueless to proceed with this quantity of sulphur to seal for nine hours and twelve hours, the quantity of gas produced not being sufficient to achieve the desired object, and the longer time within the chamber tending to induce undue sweating of the green copra without beneficial results.

*Series* 2.—Eight ounces of " flowers " of sulphur was used in the charge for these three experiments comprising this series. In this and the succeeding series of experiments the coconuts were treated as on the usual Fijian plantation by being split with an axe and the green meat cut out in fingers and smaller pieces instead of being left in the shell for the first day or two as in the case of Series 1. By this method the green meat of 1,500 nuts was required to fill the seven trays of the chamber without overloading. Further, it was in this series of experiments that the problem of ensuring the complete combustion of the sulphur was encountered and solved in the manner already described.

*Experiment* 3.—In this experiment the chamber was sealed for three hours after the burning sulphur had been placed inside. At the opening of the chamber a very strong smell of sulphur dioxide was observed. The copra was taken out and spread on the tables for drying as follows:—Sulphured—(*b*), uncovered; (*c*), covered; (*d*), control (unsulphured).

*Note.*—No copra from germinated nuts was isolated in this series. This copra took 12 days to dry. Moulds appeared on the third day, but the two following days were fine and dry and it was noted that the moulds did not visibly spread, due undoubtedly to the drier atmosphere with the quicker drying.

From the sixth day until the twelfth, when the copra was ready for bagging, the humidity of the atmosphere increased and delayed drying, with the result that the moulds increased somewhat. On the twelfth day the copra was sampled and bagged.

*Experiment* 4.—In this case the chamber was sealed for six hours, and on opening a fairly strong smell of gas ($SO_2$) was noted. The copra was drawn out and placed on tables for drying in the order noted for Experiment 3. During the time of drying the weather was usually bright, but humidity high, this accounting for the slow drying. Moulds appeared by the fourth day but did not increase. Some browning of the copra as it approached complete curing was noted, particularly amongst that copra obtained from germinated nuts. Curing was completed on the eleventh day, when the copra was sampled and bagged.

*Experiment* 5.—The nuts used in this experiment had been on hand for 28 days, were ripe when originally delivered, and in the interval many had germinated. The copra produced from this sample can therefore be classed as typical native copra. In this case the chamber was sealed for nine hours, but on opening at the end of that period only a trace of the gas was observed. On due consideration it was decided therefore that to seal the chamber for 12 hours with only a charge of ½ ℔ of sulphur would be of no practical advantage. This experiment therefore concludes Series 2. The copra was duly spread out to dry, but the weather was unfavourable for the first three days. Moulds appeared on the control sample on the third day, and on the sulphured copra on the fifth day, but in both cases development was slow, so that when the product was bagged on the fifteenth day of drying, moulding of the copra was not particularly marked.

SERIES 2.

| Expt. No. | Sulphured copra. | | Control (unsulphured) |
|---|---|---|---|
| | (*b*) | (*c*) | (*d*) |
| 3 | Appearance, dirty looking sample. Copra beetle (*Necrobia rufipes*) present<br>Quality poor. | Appearance good, some moulds and browning due to the presence of germinated nuts.<br>Quality good. | Appearance good, some moulds and browning, as in (*c*).<br>Quality good. |
| 4 | As expt. 3.<br>Quality poor. | As expt. 3, but appearance and quality rather better.<br>Quality good. | As expt. 3.<br>Quality good. |
| 5 | Appearance black, charred but flesh appears sound and good. Not attacked by the copra beetle.<br>Quality poor. | Appearance good, very free from moulds but some browning.<br>Quality good. | Appearance fair, but moulded freely.<br>Quality fair. |

The result of the experiments in this series indicates that some value may be attached to the sulphuring of the green copra, since, in the last experiment particularly, the quality of the sulphured copra was slightly better than the control.

*Series* 3.—Twelve ounces of " flowers " of sulphur was used in each of the experiments of this series, the burning being accomplished by using dry coconut husk, as already described.

*Experiment* 6.—The chamber was loaded with green copra and after the sulphur charge has been lit and placed in position, sealed for three hours. On opening the chamber it was found to be overpoweringly full of sulphur fumes and was unapproachable for some 15 minutes. After the gas had cleared, the copra was taken out and spread on the tables for drying, as follows:—Sulphured—(*b*), uncovered; (*c*), covered; and (*d*), control (unsulphured). During the process of drying some moulds showed on the control on the fourth day, but in the case of the sulphured no moulds were apparent until the copra was ready for sampling. and bagging 17 days after the sulphuring. Although unfavourable drying weather occurred during the curing of this sample of copra, the sulphured (*c*) copra remained very white and dried an excellent sample in appearance.

*Experiment* 7.—This experiment differs from Experiment 6 in that a tray of germinated nuts was set aside for special observation, as in Series 1. This was done in view of the apparent improvement of the sulphured copra in this series. The chamber was sealed for six hours, and on opening a very strong smell of gas was noted. Fifteen days were occupied in curing this copra, moulds appearing on the control on the fourth day, but not on the sulphured copra.

*Experiment* 8.—In this experiment the chamber was sealed for nine hours and on opening there was a strong smell of sulphur fumes ($SO_2$). All the trays were taken out and stood one upon another, criss-cross, outside the chamber and under cover during the week-end. This allowed for free circulation of air between the trays whilst standing from the Saturday night until Monday morning. On the fifth day of drying, moulds appeared in quantity on both the control and sulphured (*c*) copra; in the latter case two trays were particularly affected. The copra of these two trays was from old nuts and germinated nuts, and it was not clear whether this excessive moulding was due to (1) the age of the nuts, (2) undue length of time enclosed in the sulphur fumes, or (3) lack of air circulation through the method of stacking the trays after removal from the sulphur chamber. This experiment was therefore duplicated, the description of which will be found under Experiment 8A. By the 10th day of drying (Experiment 8) all moulds appeared to have ceased growth. Sampling and bagging was carried out on the thirteenth day.

*Experiment* 8A.—This experiment duplicated Experiment 8, for the reasons already given. The chamber was sealed for nine hours, a strong smell of gas being noted on opening the chamber. The copra was spread out in the usual way, receiving protection at night and from rain during the day. Sixteen days were occupied in drying. The control sample moulded freely from the fourth day onwards, black and brown moulds predominating. The sulphured sample remained practically free from moulds until sampled and bagged. The inference drawn from this duplicate experiment as regards Experiment 8 was that the difficulty met with was not due to excessive sulphuring.

*Experiment* 11.—In the previous experiments of this series there was practically no visible difference in the quality of copra produced by the various periods of sulphuring, viz., three hours, six hours, and nine hours. One other experiment was devised therefore to discover whether a shorter period than six hours would be as effective and thus economise time. For this purpose the chamber was filled with green copra and sealed for 4½ hours. On opening there was a very strong smell of gas. The copra was unloaded on to tables for drying in the usual way. Owing to weather conditions sampling and bagging was not possible until the 17th day.

SERIES 3.

| Expt. No. | Sulphured copra. | | | Control (unsulphured) |
|---|---|---|---|---|
| | (*a*) | (*c*) | (*c*) | (*d*) |
| 6 | Appearance, black and charred but flesh on breaking of a good colour.<br>Quality bad. | | Appearance good, bright copra. Practically free from moulds except for those appearing on the " germinated "<br>Quality 1st grade. | Appearance good, some moulds.<br>Quality very good. |
| 7 | As 6 above.<br>Quality bad. | Appearance good except for brown discoloration and some mould.<br>Quality good. | As (6) above.<br>Quality 1st grade. | As (6) above.<br>Quality very good. |
| 8 | Appearance very bad, red black, & brown moulds prevalent.<br>Quality very bad. | | Appearance good, some moulds which appeared to die out on the copra drying.<br>Quality 1st grade. | Appearance fair, moulded freely.<br>Quality good. |
| 8A | | | Appearance very good, colour pearly white.<br>Quality 1st grade. | Appearance fair, moulded freely.<br>Quality fair. |
| 11 | | | Appearance very good, clean and white, practically free from moulds.<br>Quality 1st grade. | As 8A, above. |

This series, judging by appearance only, definitely favours the practice of sulphuring.

*Series* 4.—This series consists of experiments in which the green copra was first washed in a suitable medium before being subjected to sulphur fumes and then sun-dried.

Throughout the preceeding experiments it was repeatedly noted that copra during the drying process often browns on or near to the edges of the meat, this discoloration not being due to moulds. This is a common complaint amongst planters, whether the copra is sun-dried or kiln dried, and the suggestion has been put forward that this is due to the small amount of sugar deposited by the " milk " as it dries from the meat, the heat of the sun or kiln causing the sugar to caramelise and produce the brown discoloration complained of. As a preventive the idea of washing the green copra after cutting out was carried out in Experiments 9 and 12, of spraying with a chemical solution in Experiments 10 and 13, while that of sulphuring after washing was carried out in Experiments 14, 14A, 15 and 15A described in this series. A further point for consideration was suggested by the Government Chemist, viz., as to whether an economical solution of some sulphur compound could be used for the washing process which, while cleansing the meat from the " milk " and therefore the sugar, would on drying decompose and automatically form a fungicidal film over the copra.

This series of experiments was carried out, using in each case the green meat from 100 coconuts, so that the results obtained may be considered as indicating possible methods of usefulness where success has been achieved to be developed on a larger scale to demonstrate the commercial value and possibilities. It is worthy of note that the idea of washing and sulphuring has since been developed on a commercial scale with success. This will be discussed further on in this paper.

*Experiment* 9.—It is generally recognised that copra dried on the beach and subject to the direct sea breeze and spray is invariably of good quality. Also, copra which has been immersed in sea water when spread out to dry in the sun is usually of good colour, appearance and quality. To demonstrate, therefore, as to whether such treatment could be recommended for general use, 100 coconuts were cut out and the green copra washed in sea water and then spread out to dry in the sun. Green moulds appeared from the third day onwards, giving the copra a spotted appearance. While these spots did not increase in size beyond that of a pin's head, the general effect was to give the copra a very poor and dirty appearance. This was due mainly to the fact that these experiments were carried out during the wet season, when atmospheric humidity is high and drying conditions generally unfavourable, as evidenced by the long time required to cure the copra. This copra was sampled and bagged on the seventeenth day of drying.

*Experiment* 12.—This differs from Experiment 9 in that the copra was washed a second time in fresh sea water. It required 14 days to dry this copra, when it was sampled and bagged. It is to be noted that the copra of these two experiments was not sulphured.

*Experiment* 10.—In this experiment the green copra was sprayed with a saturated solution of Potassium metabisulphate ($K_2S_2O_5$) by means of a " fly-tox " sprayer, 60 cc. of the solution being used. This quantity applied in this manner was found to be sufficient to ensure perfect wetting of the surface of the green copra. This copra required 19 days to dry sufficiently for sampling and bagging. It moulded freely and represented a very bad sample.

*Experiment* 13.—Twice the amount of Potassium metabisulphite solution of the same strength as in Experimental 10 was used in this case with a similar result. The solution was applied as in 10 above. It is to be recorded however that on the day of this experiment and after the copra had been sprayed, a whirlwind passed close to the open shed being used for these experiments so that the possibility of increased mould spore infection would occur. This copra was sampled and bagged on the twelfth day of drying in the condition recorded below. The result of these two experiments demonstrated that the particular salt used did not, on decomposition, automatically " sulphur " the copra.

*Experiment* 14.—In this and the three succeeding experiments some of the washed copra was sulphured while still wet with the washing solution, the charge of 12 ounces of sulphur being used, and the chamber sealed for six hours. In each case, after washing the uncured meat, the colouring matter of the brown testa of the kernel spread across the white endosperm, discolouring it, the discoloration persisting in the dried copra giving it a rather dark appearance. With the copra that was sulphured after washing, the fumes ($SO_2$) exercised a bleaching effect, destroying the discoloration referred to and producing a meat that was whiter than usual, and which retained this whiteness after drying. Further, it was noticeable that with each of these sulphured samples no moulds were visible and no injurious insects of any description were found although the copra beetle (*Necrobia rufipes*) was present in the other samples. Emphasis to this latter pecularity is given in the section of this paper devoted to the behaviour of the experimental copra in store. The copra of this experiment was washed in a 10 per cent. solution of washing soda ($Na_2CO_3$), a quarter kept for control, the remainder being sulphured for six hours, using a charge of 12 ounces of sulphur.

*Experiment* 14A.—This experiment differred only from Experiment 14 in that a 5 per cent. solution of washing soda was used.

*Experiment* 15.—In this experiment a 5 per cent solution of caustic soda (NaOH) was used, otherwise the same procedure was adopted as in Experiment 14.

*Experiment* 15A.—This experiment varied from Experiment 15 in that a 2½ per cent. solution of caustic soda was used. The copra produced in these four experiments was ready for sampling and bagging after nine days drying.

SERIES 4.

| Expt. No. | Washed. | | Control (not washed). |
|---|---|---|---|
| | Sulphured. | Not sulphured. | |
| 9 | | Seawater Covered—colour poor, moulded freely, green moulds prevalent. Uncovered, colour black, due to mould (*Aspergillus niger*).<br>Quality of both lots, very poor. | As 8A.<br>Quality fair. |
| 12 | | As expt. 9 in both cases. | As 8A. |
| 10 | | Pot. metabisulphite ($K_2S_2O_5$)<br>Colour very bad, moulded freely blacks and greens<br>Quality bad. | As 8A. |
| 13 | | Colour very bad, worse than expt. 10, all moulds and beetles.<br>Quality very bad. | Appearance fair, some moulds and browning.<br>Quality good. |
| 14 | Appearance very white, sound clean copra. No moulds, discoloration or insects of any kind.<br>Quality extra 1st grade. | Appearance fair, some greenish discoloration from the epidermis.<br>Slight moulding, some copra beetles.<br>Quality 1st grade. | As 13.<br>Quality good. |
| 14A | Appearance not so bright as 14 above.<br>Quality extra 1st grade. | As 14 above. | As 14 above. |
| 15 | As 14 above except for slight browning on many pieces.<br>Quality extra 1st grade. | Appearance dark due to staining from epidermis. Slight moulding, some copra beetles. Did not dry to the usual crispness as in the other samples.<br>Quality 1st grade. | As 14 above. |
| 15A | Appearance not quite so good as 15 above.<br>Quality extra 1st grade. | As 15 above. | As 14 above. |

From the results obtained in the washing experiments of this series it is of interest to note here that the idea of washing the copra before drying has been put into operation by E. Duncan, Esquire, at his Mua Estate, Taveuni. The copra is brought to the kiln for drying, being first weighed and then tipped on to a wire-bottomed tray under which is a draining pan. Fresh water at about 80° F., and under a natural pressure of 35 lb per square inch, is sprayed on to the green meat by means of a hose fitted with a coarse nozzle. All muck and the residue of " milk " is washed from the copra. After washing, which under this method occupies only two or three minutes, the copra is shot down on to the trays underneath and run into the kiln where in the first four hours of heating it is subjected to sulphuring. When dry this sulphured copra is exceptionally white and clean and commands a premium at the hands of the copra buyer.

### CONCLUSION.

*Series* 1-3.—Copra sold in the various markets of the world is bought more on its appearance than on its oil content. From the buyers' point of view a copra of good bright and clean appearance will give a better quality oil than a copra that is dirty, mouldy and infested with insects; the better the quality of the oil the greater the value of that oil. In judging the copra produced in the various experiments detailed, appearance has formed the basis of quality, in other words the copra has been judged from the standard of the copra buyer.

In the section devoted to the analysis of the copra by the Government Chemist will be found a standard of quality based on those analyses, but which generally follow or confirm the standard based on appearance.

As already stated, the purpose of the experiments was (1) to test out the portable sulphuring chamber, (2) to find the minimum quantity of sulphur required to secure effective sulphuring in this chamber, and (3) to study the sulphured copra.

(1) *The Chamber.*—From the results obtained in the four series of experiments undertaken it can be said that the sulphur chamber was effective for the purpose for which it was designed. It was assembled and dismantled within 30 minutes by unskilled labour, it could be readily transported by hand labour, was easily manipulated and was gas-tight.

*The Sulphur.*—The minimum sulphur charge for effective sulphuring was not discovered until after Experiment 5 of Series 2. This experiment gave the first indication that sulphured copra was by appearance, rather better than ordinary sun-dried copra as shown by the control sample.

The experiments of Series 3, demonstrated that the condition of effective sulphuring had been reached both as regards quantity of sulphur required and the time necessary for the sealing of the chamber. The minimum charge was found to be 12 ounces of sulphur and the time necessary for the operation three hours. There appeared to be no difference in quality of the copra that was sulphured for three hours as compared with that sulphured for nine hours (Series 3). The suggestion here is that the strong initial concentration of gas produced by the method of burning was sufficient to sulphur effectively the copra within the first three hours of sealing the chamber.

The sulphur burns very readily during the first hour, quickly filling the chamber with fumes. After the first hour the rate of burning decreases until the mass just smoulders but the gas then produced appears to be sufficient to maintain the concentration for another hour or so, after which the gas gradually escapes, hence the conclusion drawn from the experience of Series 3 is that effective sulphuring can be accomplished in the chamber under test by 12 ounces of sulphur in three hours of sealing.

(3) *The copra.*—For the purpose of observation the copra produced by the preceding experiments was divided under the heads:—

(*d*) control (not suplhured) and sulphured, the latter being subdivided into (*a*) uncovered, (*c*) covered, and (*b*) germinated, these subdivisions representing, in the two former, differences of treatment during drying, and in the latter a particular type of copra.

(*d*) *Control Copra.*—One outstanding feature of this copra was the regularity with which moulds appeared on the third and fourth days of drying on each sample of control copra. Taking into consideration the length of time required at the particular season of the year to effectively cure this copra, the quality at the time of bagging may be considered as " fair merchantable. sun-dried " and represented a better sample than is the case with copra produced by the average native. This improvement of quality was due entirely to the attention given it during the long drying period, viz., of protection at night and from rain, and demonstrates how with little effort, " fair merchantable sundried " copra may be produced in place of the poor quality that results from lack of attention and interest during the drying period. Nevertheless this copra was inferior in appearance and quality to the sulphured copra obtained in the experiments of Series 3.

(*c*) *Covered.*—An indication of the value of sulphuring was first noted with Experiment 5 of Series 2. In Series 3 definite improvement was noted when the sulphur charge was increased to 12 ounces, the copra appearing whiter, and during the drying remaining freer from moulds than in the case of the control (*d*), and of a higher standard of quality than any native copra or even that of many European planters. With a reasonable percentage of moisture on the green copra the sulphur fumes ($SO_2$) not only exercise the desired fungicidal effect but also bleach the copra, thereby adding considerably to the appearance of the dried copra. The difference between the various copra samples of Series 3 was not manifest in the appearance of the copra, all being apparently of the same quality.

(*a*) *Germinated.*—The copra obtained from the germinated nuts during these experiments received the same attention as (*c*) and (*d*), viz., that it received protection from rain and at night, the cover consisting of an open shed or an open garage. This type of copra is invariably thin and when dry becomes very brittle. It is greasier to the touch than copra prepared from the ripe nuts, a feature which is due to the fact that during the process of germination and the successive growth of the young plant the enzyme or enzymes which assist in that process by attacking the endosperm of green copra meat, break down the cellulose tissue and thus release the crude oil. It is this oil that gives the impression of excessive greasiness as compared with copra from ordinary ripe nuts.

In the three experiments allotted to this type of copra, in two cases—Experiments 2 and 7—the copra was definitely of poorer quality and appearance than either of the normal samples as expressed by sulphured (*c*), or control (*d*). In the case of Experiment 1, the difference was not sufficient definitely to mark it as below the standard of sulphured (*c*) or control (*d*). The conclusion therefore is that the use of germinated nuts for the purpose of copra making tends to lower the quality of the copra produced whether the copra is sun-dried or first sulphured and then sun-dried, and should therefore be avoided. With the proper and regular collection of coconuts throughout the plantations the presence of germinated nuts would be reduced to a minimum and another cause for the production of poor quality copra removed.

(*a*) *Uncovered.*—As already explained in the early part of this paper often no protection from the weather is accorded by the native to his copra during the process of curing. A small section of each experiment therefore was set aside under similar conditions and the result noted. One curious feature of this experiment was that as the sulphuring increased in efficiency so this particular copra became more and more charred in appearance and poorer in quality. Further it appeared to become more attractive to the copra beetle (*Necrobia rufipes*). The conclusion to be drawn from this experiment is that sulphuring does not improve copra which is neglected during the drying period. It is possible however that with the man who decides to improve his copra by sulphuring but fails to give that copra reasonable care during the subsequent drying will have the result of his neglect so apparent in the sulphured article as to compel him to give the required attention, and so secure the full benefit of the sulphuring operation to the further improvement of the copra.

*Series* 4.—The conclusions just arrived at dealt with the first three series of experiments. Series 4 deals with a set of impromptu experiments which, owing to the few nuts available, serve as indications of possible treatments of green copra which might prove of economical importance.

(1) *Sea water.*—It is known that sea water does improve the appearance of copra when quick sun-drying can be effected, but Experiments 9 and 12 suggest that it is more injurious than beneficial to copra when drying conditions are not favourable.

(2) *Potassium metabisulphite* ($K_2S_2O_5$).—The anticipation of automatic fungicidal action by this salt on copra did not mature, the resultant product being badly attacked by moulds and of very poor quality.

(3) *Washing-soda* ($Na_2CO_3$) and *Caustic soda* ($NaOH$).——The results obtained by the use of these two substances, particularly in Experiments 14 and 15 when after first washing in the solutions, the copra was then sulphured and cured, were startling, the washing-soda (Experiment 14) being slightly ahead of the caustic soda in appearance, but the difference was so slight that in grading they were classified as the same. It was however in storage that difference arose in favour of the washing-soda treatment, for the copra thus treated had, during the 4½ months of storage, resisted all mould and insect attack, and this in the midst of other copra that was badly infested with copra beetle (*Necrobia rufipes*), other insects and moulds. Some of this copra, after 10 months in store, was examined and found to have turned rather yellow in colour and to have sustained some attack by insects. On steeping some of this copra in water for two or three days, the water was examined and found to contain sodium sulphate, suggesting that part of the reaction occurring during the sulphuring process resulted in the formation of this salt which not only acted as a fungicide during drying and in storage, also appeared to have acted as an insecticide for this particular sample (Experiment 14) at the same time. Sodium sulphate is recognised as injurious to certain fungi, *e.g.*, smuts and bunts, so that the result attained here suggests a possible extension of its usefulness.

In conclusion therefore it may be stated that the treatment carried out in Experiment 14, namely, to wash the green copra in a 10 per cent. solution of washing-soda ($Na_2CO_3$) and then subject it while wet to sulphur fumes seems to offer possibilities for commercial use, its advantages being:—

(1) facility and cheapness with which washing soda-can be obtained;
(2) the clear and clean appearance and the high quality of the finished product;

(3) the fact that such treatment by preventing mould and insect attack would conserve the weight of copra and therefore oil produced and exported, to the advantage of the producer; and

(4) that no complications would arise with reference to machinery, &c., through the presence of minute quantities of sodium sulphate on the copra.

## SECTION I—B.

### STORAGE.

*Introduction.*—On completion of the foregoing experiments it was the intention to ship the experimental copra to the Imperial Institute, London, by the first direct boat, and for this reason the weighing of the copra was left until the time of shipment, which was expected to be at an early date. Owing to no boat being available before the writer had to leave Suva, shipment was not made until some five months later. In the following section of this paper therefore the omission to weigh the copra when placing it in store is regretted for it has prevented the obtaining of figures which would have recorded actual losses due to evaporation and insect damage, &c., as well as emphasised the value or otherwise of certain treatments.

Reference to the various indexes available in the Departmental library gives no record of work dealing with the losses incurred by copra during storage. Amongst the records of the Government Chemist, however, were found particulars of storage experiments dealing with losses by evaporation and deterioration through the increase of f.f.a. of the copra, which had been carried out by his predecessor, C. L. Southwell, B.Sc. A copy of this paper is appended so that all available information dealing with these various losses in storage may be placed on record.

On completion of the foregoing experiments the dry copra was sampled and bagged. The method of sampling adopted was that generally known as "quartering," the various types of copra produced being thoroughly mixed and quartered until 3–5 lb of that copra remained. The usual copra bags of commerce were used for bagging both samples and bulk copra. In the case of the former, the large bags were cut into four sections, each section being made into a miniature copra bag capable of holding about 7 lb of copra. The bagged copra was stored by courtesy of Mr. J. P. Tarby, Manager of the Government Rice Mill, in the old Customs Shed, Suva. This shed is a wooden structure with the usual corrugated iron roof, but it is used mainly for the storage of rice, for which purpose the floor is covered with a series of wooden gratings made out of 3 in. by 2 in. timber. These gratings allow for air circulation under the rice or copra stack and also help to reduce rat damage. Such gratings are not usual in copra stores in Fiji, and therefore represent the difference in the storage of this copra as against that in the usual commercial store. The copra was placed in this store on March 12, 1930, was examined July, 31 1930, 4½ months later, and shipped to London on August 18th, 1930, for examination, analysis and report by the Imperial Institute, whose report is awaited with interest.

The stores used for copra in Suva by the copra merchants are usually well-built iron or concrete buildings with concrete floors, well ventilated and dry and in close proximity to the wharf. At the small stores owned by Chinese and Indians, scattered throughout these islands, the copra is stored in a wooden or iron shed on either a wooden or earth floor. As the dry copra is brought to these stores by the producer it is weighed and dumped in a heap on the floor of the copra shed, if green copra is brought it is also weighed and then spread on the storekeeper's vatas, and when more or less dry, transferred to the copra shed and mixed with the copra already there to be bagged when required for shipment. The quality of this copra is invariably poor, due to lack of care and attention given either by the producer and/or storekeeper during drying and storage, for such heaps are usually alive with maggots, weevils, copra beetles, ants, &c. The loss occasioned by the presence of these insects is unknown and must constitute a serious item in the economy of copra production. The condition therefore of the experimental copra tabulated below, is of interest, particularly where such is compared with that which passes through the stores just referred to, viz., those of the Indians and Chinese:—

| Expt. No. | Sulphured. | | | Control. (*d*) |
|---|---|---|---|---|
| | (*a*) Uncovered. | (*b*) germinated. | (*c*) Covered. | |
| 1 | As (*c*). | As (*c*). | Appearance and colour bad. Badly Infested with beetles—*Necrobia rufipes* and *Calandra oryzae* (?). Lot of frass.<br>Quality bad. | Appearance good, slight browning otherwise as (*c*).<br>Quality bad. |
| 2 | As above, brown discoloration. | As above. | Appearance and colour fair. Badly infested as above.<br>Quality bad. | As above. |
| 3 | As (2) above. | | As (2) above. | As (2) above. |
| 4 | Appearance and colour bad, infestation bad.<br>Quality bad. | | Appearance fair, colour good, but infestation bad.<br>Quality bad. | As above. |
| 5 | Appearance and colour bad, infestation bad.<br>Quality bad. | | Appearance and colour good, Infestation fair.<br>Quality good. | Appearance and colour bad, infestation bad.<br>Quality bad. |
| 6 | Appearance and colour fair, but infestation very bad.<br>Quality bad. | | Appearance and colour nearly as good as (5). Infestation bad.<br>Quality fair. | Appearance and colour fair. Infestation bad.<br>Quality fair. |
| 7 | Appearance and colour bad, infestation bad.<br>Quality bad. | Appearance and colour good, infestation fair.<br>Quality good. | Appearance and colour good, infestation fair.<br>Quality good. | Appearance and colour good, infestation bad.<br>Quality fair. |
| 8 | As above.<br>Quality bad. | | As above.<br>Quality good. | Appearance and colour bad, infestation very bad.<br>Quality bad. |
| 8A | Appearance and colour fair, infestation very bad.<br>Quality bad. | | Appearance and colour very good, infestation fair.<br>Quality good. | As (8) above.<br>Quality bad. |
| 11 | | | As above (8A). | As above (8A). |

SERIES 4.

| Expt. No. | Washed. | | | Control. |
|---|---|---|---|---|
| | Uncovered. | Covered. | Washed and sulphured. | |
| 9 | Appearance, colour infestation, very bad.<br>Quality bad. | Appearance and colour fair, infestation bad.<br>Quality bad. | | Appearance and colour bad, infestation bad.<br>Quality bad. |
| 12 | As (9) above. | As (9) above. | | As (9) above. |
| 10 | | Appearance, colour and infestation, bad.<br>Quality bad. | | As (9) above. |
| 13 | | As (10) above. | | As (9) above. |
| 14 | | Appearance very good colour pearly white, infestation bad.<br>Quality 1st grade. | Appearance and colour excellent.<br>Infestation NIL.<br>Quality extra 1st grade. | Appearance and colour fair, infestation bad.<br>Quality bad. |
| 14A | | As (14) above. | As (14) above except slight infestation.<br>Quality practically extra 1st grade. | As (14) above. |

| Expt. | Washed. | | Control. |
|---|---|---|---|
| | Covered. | Washed and sulphured | |
| 15 | As 14 above.<br>Quality 1st grade. | As 14 except for very slight infestation.<br>Quality as 14*a* above. | As 14 above.<br>Quality bad. |
| 15A | Appearance and colour good infestation bad.<br>Quality good. | Appearance and colour good, infestation fair.<br>Quality 1st grade. | As 14 above.<br>Quality bad. |

*Discussion.*—Reference to the above table supports the observation made in Section I of this paper, namely, that an approach to effective sulphuring was first noted in Experiment 5, for in the condition of the copra in store it is the sulphured and protected copra of this experiment that shows to advantage over the control copra, both as regards appearance and infestation by insects, and it is noted that in each of the succeeding experiments of Series 2 and 3, that with the exception of Experiment 6, the sulphured and covered is of better quality—judging by appearance and amount of infestation by insects—than the control samples. The suggestion here is that not only does the process of sulphuring assist in checking undesirable mould growths during drying and storage but that it exercises insecticidal properties also during those periods, particularly in the latter.

In Series 4, however, Experiments 14 and 15, not only achieved the purpose of this series of experiments, but when the washed copra was duly sulphured the dried product was found not only of excellent colour and free from mould attack, but to have also been immune from insect damage during the 4½ months it was in store whilst still retaining its excellence of colour and freedom from moulds. Of the two experiments named, No. 14—that washed in washing-soda ($Na_2CO_3$) solution and sulphured—may be considered the most successful because no insect attack was discernable, whilst a slight attack was noted in the case of No. 15, where caustic soda ($NaOH$) was used. Further, in the case of Experiment 14, this is a more practical proposition from the planters' point of view, washing-soda being readily obtainable, it requires no special containers for transport purposes, and is cheap, whereas caustic soda rapidly deteriorates in humid climates, would require to be packed in special containers, is more expensive and not so easy to handle. The result obtained therefore in Experiment 14 is of importance in that it suggests a possible method of preventing losses due to insects when copra is placed in store.

On examination of this experimental copra, the whole was carefully screened and the frass obtained collected and weighed. Frass is defined, entomologically, as excrement. The frass obtained therefore represented an unknown quantity of destroyed copra, so that the results of the following calculations must be considered only as a rough approximation to the truth, especially as the frass was from two or three insects. In the case in point, 81 ℔ of frass was recovered from 25 cwt. 3 qrs. 2 ℔ of copra, equal to a loss of 2·9 per cent. in terms of frass. Assuming, however, that to produce one pound of frass 2 ℔ of copra were destroyed—quite a conservative estimate—the actual loss of copra in this case would be 5·8 per cent. of the whole, and in view of Experiment 14 would represent an avoidable loss.

103 Further, it will be noted (page ~~25~~; Section I) that the control copra of these experiments was generally of better quality than usually produced by the native, so that it is reasonable to assume that the insect damage to this experimental copra was less than it would have been in the case of native copra stored under the usual storekeeper's conditions.

To obtain some idea of what this loss means to the Colony it is estimated that the native produces at least one-third of the Colony's total copra output. The average output for the five years 1926–1930 was 28,500 tons, representing about 9,500 tons of native copra. Using the figure obtained in the storage experiment as representing loss to copra from insect attack, then the loss would be 1,600 tons per annum which at the present price of copra, viz., £9 5s. per ton at Suva, means a monetary loss to the Colony of nearly £15,000 annually.

In conclusion, reference to the *Agriculture Journal* of Fiji, 1930, Vol. 3, No. 2, page 81, will give possible losses to copra in store through mould action. If this is read in conjunction with the present paper, it will be seen that Experiment 14 especially seems to offer a suitable method whereby these enormous losses to both producer and this Colony through the ravages of moulds and insects in copra in store may, with reasonable expectation of success, be averted.

## DETERIORATION OF COPRA ON STORAGE.

By C. L. Southall, B.Sc., former Government Chemist, Fiji.

The experiments carried out during the winter of 1927 to determine the loss caused to copra by drying on open vatas pointed to the fact that further loss occurred after the copra was removed from the vata to storage. To determine, if possible, the conditions resulting in the loss and the amount of loss, the following experiments were made:—

A—Change in acidity of three commercially prepared samples of copra.

B—Slow drying on open vatas for 14 days followed by three months' storage.

C—Storage of commercially prepared copra for three months and estimation of loss at intervals.

D—Rapid drying of copra on open vatas and removal to storage for three months.

### A—*Change in acidity on storage.*

The loss of copra was unfortunately not determined but nevertheless the results are of interest:—

| Copra | 23-10-27. | | 10-12-27. | | 7-1-28. | |
|---|---|---|---|---|---|---|
| | Water. | f.f.a. | Water. | f.f.a. | Water. | f.f.a. |
| 1 | 9·1 | 4·6 | 4·9 | 12·2 | 4·7 | 11·8 |
| 2 | 7·1 | 2·9 | 4·8 | 4·2 | 4·7 | 4·4 |
| 3 | 7·4 | 2·1 | 4·8 | 4·9 | 4·6 | 4·9 |

The copra arrived in Suva on 22nd October, 1927, for shipment to Europe. Sacks of each brand were held back and stored with other copra in a bulk store, being examined at intervals.

### B—*Changes during slow drying on open vatas for* 14 *days followed by storage for three months.*

This experiment was a continuation of one reported to you on 22nd October (Ref. No. 1190/27). On the 14th day the copra was bagged and stored with other copra:

| | Slow drying on open vatas. | | Storage in presence of other copra. | |
|---|---|---|---|---|
| | 1st day. | 14th day. | 55th day. | 99th day. |
| Moisture .. .. .. .. | 45·6 | 8·0 | 4·8 | 4·6 |
| Oil content of anhydrous copra . | 68·4 | 69·9 | 70·6 | 70·4 |
| Acid in oil (as oleic) .. .. | 0·2 | 6·5 | 9·9 | 9·8 |
| Loss anhydrous copra .. .. | .... | 10·9 | 14·6 | 15·0 |

### C—*Storage of commercially prepared copra for three months and estimation of loss at intervals.*

The copra was taken at random and stored with other copra. Only moisture and loss of copra were determined:—

| Copra. | Originally Moisture. | Two months. | | Three months. | |
|---|---|---|---|---|---|
| | | Moisture. | Loss of copra anhydrous. | Moisture. | Loss of copra anhydrous. |
| 1 | 7·4 | 4·9 | 5·1 | 4·6 | 5·4 |
| 2 | 6·8 | 5·1 | 4·0 | 4·8 | 3·9 |
| 3 | 9·3 | 4·8 | 8·3 | 4·6 | 8·7 |

### D—*Rapid drying of copra on open vatas and removal to storage for three months.*

This experiment was designed to follow as nearly as possible normal working methods in Fiji. Two sacks of copra were dried as rapidly as weather conditions permitted on an open vata and bagged after four days. They were stored with other copra for three months, being tested once during the interval. The first sample was dried during fair weather and the second sample during bad weather, being rained on on each of the four days:—

| Copra No. 1. | Drying. | | Storage. | |
|---|---|---|---|---|
| | 1st day. | 4th day. | 47th day. | 89th day. |
| Moisture .. .. .. .. | 45·9 | 8·8 | 4·9 | 4·6 |
| Oil in anhydrous copra .. .. | 68·7 | 68·6 | 69·4 | 69·3 |
| Free acid in oil as oleic .. .. | 0·2 | 2·0 | 6·8 | 6·4 |
| Loss anhydrous copra .. .. | .... | 1·1 | 8·9 | 9·3 |
| *Copra No.* 2. | | | | |
| Moisture .. .. .. .. | 45·7 | 15·2 | 5·0 | 4·8 |
| Oil in anhydrous copra .. .. | 68·4 | 68·6 | 73·0 | 72·6 |
| Free acid in oil as oleic .. .. | 0·2 | 3·2 | 16·4 | 16·0 |
| Loss anhydrous copra .. .. | .... | 2·1 | 20·1 | 20·8 |

In all the above experiments allowance must be made for errors. Satisfactory sampling of copra is not easy and no conclusions should be drawn from small discrepancies between the above figures.

*Conclusions.*—Assuming the tests made to be typical I think the following conclusions may be drawn:—

(1) copra containing less than 6 per cent. moisture does not deteriorate to any great extent when stored in sacks in bulk;

(2) copra containing over 6 per cent. moisture when stored under conditions where it only loses moisture slowly, *i.e.*, in a heap of sacks, deteriorates very considerably. A loss up to 20 per cent. anhydrous copra may occur;

(3) there does not appear to be a simple mathematical relationship between increase in f.f.a. content and loss of copra, although I am of the opinion that the loss of copra is at least equal to the acidity of the oil. In the more normal experiments the proportion of loss of copra to f.f.a. was as 4 to 3.

*Acknowledgment.*—Thanks are due to Messrs. Brown & Joske for their assistance in the above work.

## SECTION II.

By W. J. Blackie, M.Sc., A.I.C., Government Chemist.

This portion of the paper deals more particularly with the chemical side of the problem of copra improvement and in a general way embodies experimental confirmation of the results of direct observation discussed in Section I of this paper.

2. In a previous paper (1) mould damage to copra was discussed in detail and some idea was given there of the commercial losses involved in the methods of preparation utilised in Fiji. The experimental results which follow tend to support many of the arguments advanced in (1), more particularly with regard to the preparation of a stable inhibitory superficial medium which would (*a*) prevent or retard the development of spores during the period of drying, (*b*) preserve the copra during storage and transit.

3. The meat of the coconut is rich in proteins, carbohydrates and fat. The surface of the meat in relation to the water is much softer than the interior and contains the products of proteolytic and hydrolytic enzymes, contained in the coconut water. The quantity of these materials such as soluble sugars, soluble protein decomposition products, &c., varies with the age of the nut and is richest in the germinating nut. When the nut is opened and the meat spread out to dry there is exposed a superficial nutrient medium and under humid conditions many of these products, more particularly the sugars, absorb water. We thus have a surface ready for spore development. Once germinated on a rich medium the organisms establish themselves and their subsequent development is ensured by the liberation of enzymes which catalyse the decomposition of the meat. The nature and extent of these enzymes was discussed in (1). It is impossible to prevent spores coming in contact with the drying meat, therefore the problem resolves itself into (*a*) limitation of spore development and from the storage point of view (*b*) limitation of subsequent mould and insect followed by mould action on the stored copra.

4. The means of attack from the above facts is obvious, also from the theoretical consideration advanced in (1), where the nature of enzymes and enzyme action is discussed in some detail. It was emphasised there the specific nature of enzyme action and its dependence on optimum conditions of hydrogen ion concentration. The amount and extent of enzyme action depends also on the manner of growth of the fungoid body. If this is inhibited in any way then decomposition is not so rapid in spite of the fact that a small quantity of enzyme can catalyse many times its own weight of reaction products. It is also to be realised that optimum conditions are necessary for the development of the spore. These conditions are realised on drying meat unprotected and include hydrogen ion concentration also, but the range for development is much wider than that required for optimum enzyme action. The development of the spore is influenced more particularly by temperature, moisture and sufficiency of food. It is possible that the materials used in this investigation to be described subsequently, may have acted as enzyme inhibitors but this is not considered to be the primary action.

5. It was realised that the methods adopted must be simple, cheap and noticeably effective and that any chemicals used must be non-poisonous, otherwise the process would not be a commercial success with native labour. This naturally limits the field of inquiry from a scientific standpoint.

## EXPERIMENTAL.

6. The following sections will be considered in turn:—

(1) sampling, and analytical methods;
(2) sulphuring of copra;
(3) washing of copra with sea water and potassium metabisulphite;
(4)—(*a*) washing with sodium carbonate 5 and 10 per cent. solution;
(*b*) washing with sodium carbonate followed by sulphuring.

7.—(1) *Sampling and analytical methods.*—It is necessary in investigations such as these to obtain representative samples. This is particularly hard with copra, since it is known that oil, free fatty acid and moisture may vary considerably, even in different portions of the same nut. The haphazard methods usually adopted of removing a pound or two of the material from a sack and using this for the analytical operations would be useless here, in as much as the success of the methods depended upon obtaining representative samples for comparison.

8. The methods adopted by the Malay workers were considered too detailed for our purpose and after reviewing these and other sampling methods it was considered that the usual quartering method as modified by us gave fairly good representative samples. The following procedure was therefore adopted. The whole of the material as prepared in Section 1 of this paper was spread out on a board and after thorough mixing with a spade was quartered in the usual manner until a quantity of about 2 ℔ was obtained. This was first of all bottled, but later experiments displayed the fact that it kept better if sewed up in a small bag. Moreover, it more nearly represented commercial conditions in storage. From each piece of copra so obtained three pieces ⅜ in. in diameter were punched out by means of a metal punch. Each piece so removed was sliced up by means of a razor blade into small portions less than one millimeter in thickness. The material so obtained was further mixed and quartered until a representative sample for analysis was secured. Remarkably concordant results were obtained through sampling in this manner. The analysis was carried out in the usual way except that the moisture was determined in a vacuum oven and the oil determined on this dried material. The oil was extracted in a Soxhlet Extractor after being ground up with sand using petroleum ether as solvent. Owing to the fact that (*a*) despite extreme care sand and other particles passed into the extraction flasks, (*b*) the bottoms of the flasks were sometimes covered with a deposit from the boiling water in which the flasks were immersed, (*c*) under high humidity conditions an extraction flask even although suitably counterpoised presents too big a surface for condensation of moisture during weighing, the following procedure was adopted with success. The oil after extraction was evaporated with recovery of solvent to a small volume, the residue was filtered through a small Whatman filter paper, the flask being washed with successive small quantities of petroleum ether poured through the filter paper. The filtrate was collected in a small weighed platinum basin and after gentle evaporation in the water bath last traces of solvent removed in the vacuum oven. Free fatty acid was determined in the usual way by expression solution in neutral alcohol, and titration with $\frac{N}{10}$ Sodium Hydroxide using Phenolthalein as indicator.

9.—(2) *Action of sulphur dioxide on copra.*—A large amount of work has been done on the sulphuring of fruits, &c., in order to preserve them. Except for a limited amount of work carried out in the Philippines (2) and elsewhere, little has been done on the sulphuring of copra. Southall (3), a summary of whose work will be included, carried out experiments with interesting results, but both his work and that of the Philippine workers suffered from incompleteness. It was therefore thought that a thorough investigation of the claims made for sulphuring copra was necessary since sulphur is a cheap product and readily available in Fiji. The plant described in the first section of this paper was therefore constructed and experiments performed as described there, using varying charges of sulphur and varying times of sulphuring.

10. In order to obtain complete comparison samples of untreated copra were subjected to drying along with the treated material. A control was thus obtained and in almost every case distinct controls were used in each experiment. During the earlier work difficulty was encountered with the sulphur combustion, but after several attempts to obtain complete firing, success attended the use of sulphur mixed with coconut husk as described in Section I. With the heavier charges of sulphur and complete combustion the chamber was soon filled with an atmosphere of sulphur dioxide, and after the completion of the experiment the air in the chamber was still charged with a high content of $SO_2$. The earlier experiments suffered from incomplete firing and a consequent low percentage of $SO_2$ in contact with the meat. The trays were constructed and arranged in the chamber to permit of the greatest possible surface of meat coming in contact with the sulphur dioxide charged atmosphere. After sulphuring the copra was dried along with the control and samples were taken, prepared and analysed as described above.

During 1927–28 sulphuring experiments (3) were carried out at Wakaya and Taveuni with a type of chamber similar to that described in Section I of this paper. From the description of the plant as described in the records of this Department it would not appear to have been as suitable as the one used for these experiments, the main features of which were durability, portability and efficiency. Sulphuring was carried out from four to twelve hours with varying quantities of sulphur, not specified. Difficulty was experienced with the combustion, but it was stated that if the sulphur was spread out on a thin plate to a depth of half an inch combustion took place slowly. We could not obtain efficient combustion by this method and therefore adopted the procedure outlined above.

A summary of the experimental results obtained under conditions to be described and the analytical data after preparation and storage for three months is given below.

(1) Copra sun-dried covered at night. The unsulphured meat dried rapidly and was badly burnt, having dried in three days. The sulphured meat remained clear white: burning was absent:—

TABLE 1.

| | Sulphured when prepared. | After 3 months storage. | Unsulphured when prepared. | After 3 months storage. |
|---|---|---|---|---|
| Moisture (per cent.). | 6·9 | 5·4 | 5·1 | 4·8 |
| F.F.A. (per cent.) .. | 0·17 | 1·6 | 1·2 | 3·4 |
| Oil colour .. .. | White. | White. | Light yellow. | Light yellow. |
| Appearance of copra | White. | White with copra bugs in cracks. | Burnt. | Burnt, very dusty, larvæ and copra bugs. |

(2) Two samples sulphured and unsulphured, sun-dried for one day, uncovered for one night to heavy rain, then dried for three days:—

TABLE II.

| | Sulphured When prepared. | After 3 months storage. | Unsulphured when prepared. | After 3 months storage. |
|---|---|---|---|---|
| Moisture (per cent.). | 5·7 | 5·1 | 4·9 | 4·6 |
| F.F.A. (per cent.) .. | 0·34 | 2·0 | 7·6 | 8·1 |
| Oil colour .. .. | White | White. | Yellow. | Deep yellow. |
| Appearance of copra | White. | White, but containing copra bugs and larvæ. | Brown mouldy | Brown, copra bugs and larvæ more extensive. |

(3) Sulphured and unsulphured sample placed in a damp shed without air drying. Humidity increased by covering with corrugated iron. Each night for eight nights the iron was removed and copra sprinkled with water. After this period the sulphured sample appeared unchanged, the unsulphured a slimy mass of moulds:—

TABLE III.

| | Sulphured When prepared. | After 3 months storage. | Unsulphured when prepared. | After 3 months storage. |
|---|---|---|---|---|
| Moisture (per cent.). | 5·9 | 5·3 | 5·1 | 5·0 |
| F.F.A. (per cent.) .. | 0·34 | 1·79 | 9·6 | 11·5 |
| Oil colour .. .. | White. | White. | Light brown. | Dark brown. |
| Appearance of copra | White. | White with larvæ and copra bugs. | Very mouldy and dark. | Dark with more extensive larvæ and copra bugs. |

If we summarise these results for the free fatty acid we obtain:

TABLE IV.

| | Sulphured. March—June. | | | Unsulphured. March—June. | | |
|---|---|---|---|---|---|---|
| | % | | % | % | | % |
| I | ·17 | to | ·16 | 1·2 | to | 3·4 |
| II | ·34 | to | 2·0 | 7·6 | to | 8·1 |
| III | ·34 | to | 1·7 | 9·6 | to | 11·5 |

It would therefore appear that sulphuring of copra had much to commend it.

The following are the results of the analyses of the experimental material prepared as described in Section I of this paper. The experiments are more detailed and the results obtained are similar to those described above. In order to facilitate comparison I have tabulated the results in a manner similar to that in Section I:—

SERIES 1—TABLE V.

| Expt. No. | Sample. | Water. | Oil on water free. | F.F.A. |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| 1 | Unsulphured control .. | 7·95 | 67·45 | 0·88 |
| | Sulphured germinated .. | 6·98 | 68·22 | 3·29 |
| | Sulphured uncovered .. | 8·21 | 70·54 | 1·30 |
| | Sulphured covered .. | 8·92 | 68·44 | 1·76 |
| 2 | Unsulphured control .. | 9·10 | 63·54 | 2·37 |
| | Sulphured germinated .. | 7·41 | 65·89 | 9·75 |
| | Sulphured uncovered .. | 8·09 | 62·93 | 3·21 |
| | Sulphured covered .. | 6·59 | 67·70 | 4·31 |

*Note.*—The "free fatty acid" figures are expressed as per cent. lauric acid. "Oil on water free" refers to oil on the dry basis.

In this series, the results of which were obtained one month after preparation, it is seen that if anything the control sample is the better with F.F.A. at ·88 as in Experiment No. 1 and 2·37 in Experiment No. 2. According to the F.F.A. figure the control in both cases is 100 per cent. better, although the appearance of the copra suggested very little difference. The germinated material in Experiment No. 2 was extremely poor and it would appear that sulphuring under the conditions described has not the ability to arrest anzyme action once it has commenced in the meat of the germinated nut. This would tend to prove the fact that sulphuring is a surface action.

SERIES 2—TABLE VI.

| Expt. No. | Sample. | Water. | Oil on water free. | F.F.A. |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| 3 | Control .. .. .. | 8·16 | 64·09 | 1·09 |
| | Sulphured uncovered .. | 9·03 | 73·95 | 5·03 |
| | Sulphured covered .. | 8·27 | 67·08 | 2·49 |
| 4 | Control .. .. .. | 6·71 | 64·4 | 0·61 |
| | Sulphured uncovered .. | 8·16 | .... | 5·44 |
| | Sulphured covered .. | 6·76 | 67·5 | 0·67 |
| 5 | Control .. .. .. | 5·44 | 69·20 | 1·22 |
| | Sulphured covered .. | 6·50 | 64·21 | 0·42 |
| | Sulphured uncovered .. | 7·30 | 66·29 | 7·25 |

The figures for this series were obtained six weeks after preparation of material. In Experiment No. 3 the control would appear to be the best sample. In Experiment No. 4 there is very little difference between the control and sulphured covered, while in Experiment No. 5 the sulphured covered is the best sample, although the control was quite good. It would therefore appear that the chemical evidence bears out the observations made on Series 2 in Section I of the paper.

SERIES 3—TABLE VII.

| Expt. No. | Sample. | Water. | Oil on water free. | F.F.A. |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| 6 | Sulphured covered .. | 6·50 | 64·6 | 0·83 |
| | Sulphured uncovered .. | 8·50 | 69·2 | 4·37 |
| | Control .. .. .. | 5·05 | 70·3 | 0·76 |
| 7 | Germinated .. .. | 5·8 | 63·4 | 0·67 |
| 8 | Sulphured covered .. | 6·11 | 65·6 | 2·68 |
| | Sulphured uncovered .. | 8·08 | 66·9 | 21·39 |
| | Control .. .. .. | 10·00 | 70·1 | .... |
| 8A | Sulphured covered .. | 7·54 | 69·26 | 1·00 |
| | Control .. .. .. | 7·22 | 64·8 | 10·72 |
| 11 | Sulphured covered .. | 10·00 | 68·7 | 3·94 |
| | Control .. .. .. | 7·22 | 64·8 | 10·72 |

The results for this series were obtained 2½ months to 3 months after preparation and bagging. In Experiment No. 6 of this series the control appears to be every bit as good as the sulphured product, but enzyme action in the germinated sample, experiment No. 7, appears to have been arrested with the production of an excellent sample. The sulphured products in 8A and 11 are much superior chemically to the control when it is considered that Experiment No. 11 was completed three months after the preparation of the material. The water content is high in the sulphured copra in Experiment No. 11 due to the wet conditions under which it was prepared, nevertheless with this high water content mould damage on the basis of the F.F.A. figure is 2·73 times less than the control, with only 7·23 per cent. of water. These figures were re-determined two months later, that is, five months after the preparation of the sample, with the results displayed in Table No. VIII. The control sample had markedly deteriorated during this period. It is therefore seen that the water content on storage has dropped from 10 to 3·93 and by sulphuring the F.F.A. has only increased to 4·22, that is, 7 per cent. increase.

The original intention was to repeat the determinations as obtained above three months afterwards, but pressure of other work forbade this for every case. In any event each series was complete in itself.

In the case of Series 3, determinations were made three months after the material was bagged. Moisture and F.F.A. were re-determined on the more important samples with the following results:

TABLE VIII.

| Expt. No. | Nature of sample. | Three months after preparation. | | Five months after preparation. | |
|---|---|---|---|---|---|
| | | Water. | F.F.A. | Water. | F.F.A. |
| | | Per cent. | Per cent. | Per cent. | Per cent. |
| 6 | Sulphured covered .. | 6·50 | 0·83 | 4·06 | 0·98 |
| | Sulphured uncovered .. | 8·50 | 4·37 | 4·74 | 5·36 |
| | Control .. .. .. | 5·05 | 0·76 | 3·92 | 1·04 |
| 8A | Sulphured covered .. | 7·54 | 1·00 | 4·23 | 1·51 |
| | Control .. .. .. | Badly damaged by mould action. | | | |
| 11 | Sulphured covered .. | 10·00 | 3·94 | 3·93 | 4·22 |
| | Control .. .. .. | 7·22 | 10·72 | Badly attacked by moulds. | |

The control in sample No. 6 gave a better figure for F.F.A. (1·04 per cent.) than the condition of the material would suggest, since it was a very inferior looking article. The percentage increase in acidity 18·1 and 36·9 for the sulphured covered and control respectively gives a better indication of the state of the material. The sulphured covered in Experiments Nos. 8A and 11 had increased in per cent. acidity 51 and 7 respectively. So far no mention has been made of the sulphured uncovered material. On consulting the tables above it is seen that this copra, from Experiment No. 3 onwards from the point of view of the F.F.A. figure, is much inferior to either the control or the sulphured covered. The high figure of 21·39 per cent. of free acidity is reached with the sulphured uncovered product, whereas the covered material contained only 2·68 per cent. F.F.A. These results do not strictly compare with those of Southall (3) (see Table III above), since we did not protect the sulphured uncovered product in any way, whereas his material was uncovered for an experimental period and then dried normally. It is thus to be noted that sulphuring does not protect the copra if the latter is uncovered to all weathers. It does, however, assist materially in producing a good grade copra under high humidity conditions if care is taken in protecting against rain and dew falling intermittently on the material during drying operations. The sulphured uncovered product more nearly represents usual quality copra as produced in Fiji. The figures also display the fact that with care a fair grade copra can be produced without sulphuring. Some of the controls above were quite good even after three months storage but it is to be remembered that these controls were protected at all time during drying from the weather. The sulphured product scores over the unsulphured material dried under similar conditions in (*a*) having a cleaner almost bleached appearance, (*b*) lasting better on storage, (*c*) drying to a better grade material under high humidity conditions, (*d*) being a little less prone to insect attack on storage. It does not, however, in all cases appear to have the same crisp appearance nor is it so easily fractured as a good quality sun-dried sample. It is in fact generally quite leathery and bends rather than fractures. These points are of commercial importance, but the quality of the material outweighs these apparent physical characteristics. The sulphured meat appears also to shrink less on drying and it can contain a higher water content than the unsulphured material without excessive mould action.

With regard to the chemical action of sulphuring, little can be said as yet. The primary action is no doubt the production of an acid surface which inhibits the development of spores. Nevertheless, when spores do develop on the strongly sulphured meat the fungus body does not flourish so well as on untreated meat, also the sulphured product has a greater resistance against mould action on storage, after a period when it can reasonably be considered that surface resistance has ceased. From these observations it would appear that sulphuring has a more deep seated effect on the copra inhibiting internal breakdown and external enzyme action.

It seems almost probable that some type of enzyme inhibitor is produced by the sulphuring of wet meat. It did not appear necessary at the commencement of this work to determine the quantities of sulphur over and above that normally present in the copra, also the type of sulphur compounds, but in the light of the results obtained such an examination would make an interesting contribution to our present knowledge of the process.

In the above experiments the F.F.A. figure was taken as an index of quality rather than the oil figure. The nuts used in the experiments were of all ages, and quartering was not resorted to in setting aside the material for drying, nor were equal quantities of material set aside so that in any one series the composition of the copra would differ to a greater or lesser extent. This is well displayed in the oil figures obtained. The F.F.A., which is a measure of oil decomposition, would not be so effective.

From the results of these determinations it can be concluded:—

(1) Sulphuring of copra, using the plant described under the conditions laid down in Section I for Experiments 8 and 11, produced an excellent quality copra.

(2) After storage for five months the sulphured product was in appearance superior to untreated copra prepared by the usual methods adopted in Fiji.

(3) On the basis of the F.F.A. figure sulphured copra lasts better on storage and is a commercial article when untreated Fiji copra has materially decomposed.

(4) If care is taken during drying operations a good quality sun-dried copra can be made without sulphuring, but this does not keep so well on storage. This conclusion is based upon results obtained with our controls, but does not hold for copra as prepared by certain planters in Fiji.

(5) Sulphured copra uncovered to weather during drying does not resist mould action, but for intermittent showers it lasts better than normal Fiji copra.

(3) *Washing of copra with sea water and potassium metabisulphite.*—In the introduction to this section of the paper it was pointed out in paragraph 4 that when the wet meat is laid out to dry there is exposed to spore action a surface containing soluble carbohydrates and protein hydrolytic products. It was therefore thought by washing the meat before drying that a large amount of these products might be removed and that therefore mould action would be limited to some extent. It has been frequently observed that copra made near the coast, where sea breezes containing salt spray can come in contact with it, has a better appearance than that prepared inland. The obvious conclusion is that the sea air in some way limits mould action. There would appear to be some slight scientific grounds for this conclusion since in a recent paper (H. R. Curran (4)) it has been shown that increase of osmotic pressure of the medium by sodium chloride has a retarding effect on the development of bacterial spores. It was therefore decided to wash copra with sea water and dry it in the usual manner. The following results were obtained:—

TABLE IX.

| Expt. No. | Sample. | Water. | Oil on water free. | F.F.A. |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| 9 | Control .. .. .. | 7·22 | 64·87 | 10·72 |
| | Sea water single wash .. | Rotted through by fungi. | | |
| 12 | Sea water double wash .. | 8·18 | 62·65 | 3·18 |

The single washed sample decomposed early, but the double washed material appeared quite good when prepared and lasted longer. It had, however, become almost worthless after five months' storage and much inferior to the control which, as stated above in Table 8, was badly attacked by moulds, copra bugs and larvæ after five months' storage.

It would therefore appear that washing with sea water had no effect in arresting mould action. These experiments were conducted during bad weather and drying took from 14 to 17 days. It would be necessary to repeat this work under better drying conditions.

It was thought that better results might be obtained by washing with potassium metabisulphite. Metabisulphites are considered to be extremely stable non-hygroscopic substances and are unaffected by air. It was realised that this material is expensive and could possibly not be used commercially, but we had found no reference to its use as an enzyme inhibitor. The sample of metabisulphite which we used appeared to be decomposing with the liberation of sulphur dioxide and it was considered that a type of automatic sulphuring might result from its use, especially in contact with drying meat.

The results, however, were extremely unsatisfactory for both the singly and doubly washed materials which were very badly decomposed, soon after preparation. No determinations were made. However, drying took 19 days with the singly washed and 12 days with the doubly washed. These conditions, as with the sea water washed, were abnormal and a better product may have resulted under more normal drying conditions. The work was not continued with at this stage.

(4) *Washing with sodium carbonate* 5 *and* 10 *per cent. solution.*—Considering that the primary action with sulphuring is the formation of an acid inhibiting surface it was argued that similar results could be obtained with an alkaline surface. It was also thought that by washing with an alkaline reagent of sufficient strength that the dual purpose of removing nutrient material from the surface of the meat and at the same time creating an alkaline surface would be served. It has been stated by Webb (5) that in equal concentrations of the ions the O.H. ion appears to be relatively more toxic to the spores he studied than H. ions. He used, of course, artificial media. Levine Buchanan and Toulouse (6) have shown that by the addition of sodium chloride, sodium carbonate and sodium phosphate to caustic soda contained in a suitable medium bacteria were killed more rapidly. Therefore it is the caustic soda itself, not the O.H. ions which, by penetrating the cells, caused death. Meyer (7), however, considers that the action is due to the concentration of the hydroxyl ions. It would not appear that the sodium and potassium ions have any effect, although it is pointed out by Marloth (8) that sodium ions in high concentration are toxic.

The copra prepared by washing in 5 and 10 per cent. sodium carbonate solutions as described in Section I were analysed after five months' storage. The material was in splendid condition and the results obtained were as follows:—

TABLE X.

| Expt. No. | Sample. | Water. | Oil on water free. | F.F.A. |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| 14A | Sodium carbonate 5% .. | 4·69 | 63·02 | 1·19 |
| | Sodium carbonate 10% .. | 5·13 | 64·08 | 0·98 |

It is thus seen that 5 per cent. and 10 per cent. carbonate solutions were effective in limiting mould action, the figure 0·98 being very satisfactory for copra of this age. As far as could be seen this material, except for slight discolouration, appeared sound and was classed as first grade.

Some of the material from the 5 per cent. and 10 per cent. carbonate washed, was sulphured. The results obtained were striking and a product was produced that entirely resisted mould action. It had the bleached appearance of sulphured copra and the analytical figures obtained for the 10 per cent. washed and sulphured after five months' storage were as follows: Moisture, 5·09 per cent.; oil on water free, 61·93; F.F.A., 1·42. This product was considered the best obtained and was classed as extra first grade. It had entirely resisted mould action after five months' storage.

As far as the analytical data is concerned the " carbonated sulphured " would not appear to be in any way superior to the unsulphured carbonated, but its appearance is very much better and it showed no mould development after five months' storage.

### SUMMARY.

It has been shown (1) that washing copra with 5 and 10 per cent. solutions of sodium carbonate produces good quality material that markedly resisted mould growth, (2) by washing with 10 per cent. sodium carbonate followed by sulphuring a first grade material was obtained which appeared to entirely resist mould action, (3) the sulphured carbonated copra had a better appearance than the carbonated. It also dried well and had the crisp and easily fractured nature of good quality sun-dried.

In attempting to explain the underlining process of the various attempts to produce a mould-free copra one is faced with lack of experimental details. The experiments outlined above were considered more from the commercial aspect than the scientific. Nevertheless, certain facts were adduced which throw a little light on the matter. Fifty grammes of the materials prepared as above were washed with 50 c.c.s. of distilled water 12 months after preparation and a qualitative analyses made of filtrates. Also 20 grammes of the internal material obtained by removing the entire exposed surfaces as completely as possible were also washed with 25 c.c.s. of distilled water and the filtrates qualitatively analysed. The results obtained are as follows:—

TABLE XI.

| | Surface washed | | | | Internal washed. | | | |
|---|---|---|---|---|---|---|---|---|
| | Control. | Sulphured. | Sul. Carb . | Carb. | Control | Sul | Sul. Carb. | Carb. |
| Carbonate .. | Absent | Absent | Trace | Present | Absent | Absent | Trace | Present |
| Sulphates .. | Absent | Present | Present | Absent | Absent | Present | Present | Absent |
| Sulphites .. | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

Only small amounts were present, but the substances were definitely recognised. Of the metallic ions only sodium and possibly potassium were recognised. Calcium magnesium aluminium and iron did not appear to be present in sufficient quantities to be recognised. These results are interesting for it seems evident, as pointed out above, that sulphuring is not altogether superficial and the same would apply to the action of sodium carbonate. Quantitative estimations were not made. It appears (1) that in the sulphured product sulphur dioxide permeates the whole of the meat and in solution comes in contact with possibly potassium soluble salts which are known to be present in coconut water, forming potassium sulphite which is oxidised to the sulphate. The exact nature of the reaction is not known except that the sulphate ion is definitely recognised after twelve months' storage; (2) the carbonate ion permeates the meat; (3) sulphate, probably sodium sulphate, is found in the interior of the meat after washing with sodium carbonate and sulphuring.

Taking these rather scanty facts into consideration and from the foregoing discussion under the various sections it seems as if the main actions are:—

(1) The sulphurous acid acts first in producing a superficial medium of high H. ion concentration which retards development of spores. The $S.O._3$ ion also acts tocixologically on spores through the inhibition of enzyme action and on a surface of high concentration of salt produced by evaporation spore development may also be decreased by increase of osmotic pressure. The toxicological action is enhanced by oxidation to the sulphate and the keeping power is enhanced by the presence of this toxicological ion within the meat.

(2) The washing with sodium carbonate produces a superficial medium of high O.H. ion concentration which retards the development of spores. This surface action is greater than with the H. ion concentration produced by sulphurous and sulphuric acid owing to the greater toxicity of the O.H. ion. The presence of sodium carbonate within the meat assists storage, but it is considered that the toxic action of this ion is less than that of the sulphate or sulphite ion and that its chief internal action is the presence of a high O.H. ion concentration. Osmotic pressure may also superficially play its part here.

(3) The washing with sodium carbonate followed by sulphuring retards development, as described above, but the presence in comparatively high concentration of sodium sulphate gives the product greater resisting power owing to the presence of the highly toxic sodium and sulphate ions.

The difference between the sulphured product and the sulphured carbonated product is one of degree, also the presence of more toxic sodium ion in greater concentration.

It is to be noted here that in the case of " carbonate sulphured " product that all the spores that normally affect copra are prevented from developing.

## CONCLUSION.

There are many opinions as to the exact nature of the reactions of fungi to H. and O.H. ions. It is considered by Boeseken and Waterman (9) that the action of the H. ion is to precipitate the negatively charged albumin and lecethin colloids in the cell wall of the spore, and it is possible that the O.H. ion acts similarly by discharging the positively charged colloids. Marloth (8) suggests that " since the proteins in the protoplasm are amphoteric in nature it may also be possible that the influence of the hydrogen and hydroxyl ion is such as to reverse the charge on certain proteins causing a disruption of the protoplasm within the cell." The opinion is also expressed by Marloth (8) with reference to the action of sodium bicarbonate on penicillium Italicum that the decay of citrus fruit is prevented by the fact that when the spores develop or commence to develop there is present on the rind a surface film of saturated bicarbonate solution which acts on the proteplasm of the thin wall germ tube or at that point on the spore where the wall is thinned for the emergence of the germ tube. This action is probably more important than the osmotic action discussed above, and it is considered that sodium carbonate and sulphate acts in a similar manner, also that the internal action is somewhat similar within the dried meat of the copra.

From these experiments it would appear that washing with sodium sulphate would produce a good grade copra, and experiments will be instituted to prove this point.

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## EXAMINATION BY THE IMPERIAL INSTITUTE, LONDON, REMARKS AND CONCLUSIONS.

MOST of the samples had suffered somewhat in appearance owing to insect attack. When allowance has been made for this defect, the following conclusions can be drawn from the results of the examination.

1. *Effect of Sulphuring* (*Experiments* I *to* VIII—A *and* XI).—The best of the sulphured samples dried under cover was No. VIII—A, sulphured and covered, which had been treated with 12 oz. of burning sulphur for nine hours. This sample was a duplicate of No. VIII, sulphured and covered, but was of better appearance.

2. Although No. VIII—A, sulphured and covered, is better than its control, it is not quite equal to the standard of the control to No. III. From this it might be concluded that the sulphuring of the copra before drying had not produced a better product than can be prepared without this pretreatment.

3. No. VIII—A, sulphured and covered, was treated with as much burning sulphur, and for as long a time as any of the sulphured and covered samples; in fact, its treatment was more severe than any other of such samples, except its duplicate in Experiment VIII. It might therefore be expected that a slight but gradually increasing improvement would be shown by the samples in proportion to the amount of sulphur used and the length of the treatment. Such an improvement is in fact shown in most cases. Where the samples have all received the same amount of burning sulphur, the effect produced by the varying lengths of the treatment is not very apparent.

4. One of the objects of sulphuring the copra before drying is doubtless to prevent the copra from becoming mouldy during drying. Treatment of the material for this purpose would, however, appear to be unnecessary, as none of the controls showed mould.

5. One effect of sulphuring the copra and drying it under cover would appear to be to reduce the acidity of the extracted oil. The effect on the colour of the oil and the meal is not uniform; in some cases the oils from the treated copras are better than those from the control, and in other cases not so good.

6. Any good effect that might be produced by sulphuring is undone by drying the copra uncovered. Sulphured and uncovered samples generally have a poorer appearance and yield an oil with a higher acid value and of poorer colour than those that have been sulphured and dried under cover. It is to be noted, however, that the oil content of the sulphured and uncovered samples is generally slightly higher than that of the control and of the sulphured and covered samples. Many of the sulphured and uncovered samples were mouldy.

7. The three vara samples were rather thinner than the controls, and yielded oils with an acid value slightly higher than that of the oils from the sulphured and covered samples; otherwise they were very similar to the latter samples.

8. *Sea-water* (*Experiments* IX *and* XII).—The effect of sea-water does not appear to be as good as that of sulphuring. The double-washed sample was slightly darker both as regards the inner surface and internally than the once-washed sample, and gave a browner oil and a meal of poorer colour.

The once-washed, uncovered sample had a slightly higher oil content than the control or the covered sample, and yielded a foxy-red oil of very high acidity and a meal of poor colour.

9. *Potassium meta-bisulphite* (*Experiments* X *and* XIII).—Treatment with meta-bisulphite does not show any advantage over sulphuring. No. XIII, treated with 100 c.c. of solution, was not so good as No. X treated with 60 c.c. of solution, and gave a foxy-red oil of higher acidity and a meal of poorer colour.

10. *Sodium carbonate* (*Experiments* XIV *and* XIV—A).—These samples are better than the control and compare very favourably with the sulphured and covered samples of the earlier experiments. Sodium carbonate has the effect of reducing the oil content slightly, and when a sample so treated is sulphured the acid value of the extracted oil is lowered. The sulphured samples are slightly better in appearance than those which were only washed. Varying the amount of carbonate used does not produce any appreciable effect, though the sulphured sample treated with 10 per cent. is slightly better than that treated with only 5 per cent. No. XIV, washed and sulphured, is very slightly better than No. VIII—A, sulphured and covered.

11. *Caustic soda* (*Experiments* XV *and* XV—A).—These samples, like those of Experiments XIV and XIV—A, are better in appearance than the control, and compare very favourably with the sulphured and covered samples. They are very similar to those treated with sodium carbonate. In these cases also treatment with alkali has slightly reduced the oil content, and the sulphured samples yielded oils with lower acid values than the control. The sulphured samples are slightly better in appearance than those which were only washed. The sulphured sample, treated with 2½ per cent. solution of caustic soda, is similar to No. XIV washed with 10 per cent. sodium carbonate and sulphured. No. XV—A, washed and sulphured, is very slightly better in appearance than No. VIII—A, sulphured and covered.

12. *General conclusions.*—These experiments show that no advantage is obtained by treating copra, before drying, with sea-water or with potassium meta-bisulphite.

13. Copras treated with alkali and sulphured before drying give better products than the untreated control samples, and the indications are that treatment with the fumes of burning sulphur for nine hours before drying under cover definitely improves the quality of the resulting copra.

14. The control samples and the sulphured samples dried under cover are generally of better appearance than samples of plantation Fiji copra previously examined at the Imperial Institute.

### COMMENTS.

1. The above remarks and conclusions bear out in the main the results obtained during this investigation.

2. It is, however, to be understood that a strict comparison of the findings of the Imperial Institute with our results is not possible, owing to the fact that the weather conditions were not fully appreciated.

3. In dealing with the " objects of sulphuring copra " the suggestion is misleading, being based on the fact that the copra in question had an average moisture content of 4 per cent. on examination in London. Such copra does not favour mould growth and the moulds which had developed when moisture was 12 per cent. and over would tend to die out when the copra dried, leaving, where mould colour permitted, a stain to indicate previou infection. Also in paragraph 2 of the summary reference is made to the

fact that although No. VIII—A, sulphured and covered, is better than its control, it is not quite equal to the standard of the control of No. III. It is readily seen that it was essential to have a control in each case, owing to variations in the compositions of the meat (which was made as uniform as possible for each individual series) and drying conditions from experiment to experiment. It is, therefore, not correct from our point of view to compare the control of one experiment with the controls and treated products of other experiments.

4. It has been frequently noted here that very badly decomposed copra has a higher oil figure than one would expect. This was noted during work with regard to the sulphured uncovered (see Tables, Section II), and was referred to by the Imperial Institute in paragraph 6 above. This high oil figure is, however, only apparent and may be due to either a greater selective rate of decomposition of the components other than oil in the copra, with the escape of volatile products, or to products other than oil appearing in the petroleum ether extracts as a result of this decomposition. This point is very interesting, for the oil contents of sulphured uncovered samples appeared to be very much higher than the controls. It would appear from this that the treatment, sulphur di-oxide and excess moisture favoured the selective decomposition of components other than oil in the meat.

5. Paragraphs 10 and 11 of the Remarks and Conclusions dealing with the sodium carbonate and caustic soda treatments make very interesting reading. The Imperial Institute have noted the important point that the acid value of the oil has been lowered by treatment with alkali and sulphuring. This bears out our conclusions obtained many months previous to the Institute's examination and points to the fact that the treatment inhibits in a marked manner the production of f.f.a. from the oil, that is, that mould damage has been reduced to a minimum. It was stated by the Imperial Institute in their detailed report that experiment No. XIV (washed with sodium carbonate 5 per cent. and sulphured) was free from insect attack. This important fact was not mentioned in the conclusions and remarks quoted above. We had certified the sample as free from insect and mould attack on July 21st, 1930 (see Series 4, page 101) and it was again certified as free from insect attack on arrival in London—eight months after bagging. During this long period the sample was in intimate contact with badly infested copra. The estimated loss on storage due to insect damage has been dealt with in Section I—B, page 105, and the suggestion is that the process involved in Experiment XIV deserves investigation on commercial lines. It is encouraging to learn that the "carbonated" samples are better than the controls and also No. XIV, washed with sodium carbonate and sulphured, is slightly better than VIII—A, sulphured and covered.

6. Considering the general conclusions of the Imperial Institute quoted above the comment concerning copra treated with sea-water is only correct for the conditions obtaining during these particular experiments, the controlling factor being the weather.

7. With regard to the time necessary for sulphuring it would appear from the fact stated in Section I, page 103, that nine hours does not appear to be necessary.

8. The statements with regard to the treated samples are in accord with our own, except that in our opinion, considering all available information, including the results obtained by the Imperial Institute with regard to freedom from insect attack and low acid value of extracted oil, that the samples washed with five per cent. sodium carbonate and sulphured is much superior to the other treated material.

9. The report received from the Oil Crushers per the Imperial Institute letter, 0/2295 of the 30th July, 1931, gives further striking confirmation to the findings of this investigation and is given in full below:—

> " With reference to my letter of the 7th July, a report has now been received from the firm of copra brokers. The samples forwarded to them were labelled from A to H and represented the results of the experiments mentioned below:—
>
> A—Control to Exp. III, unsulphured, sundried.
> B—Exp. VIIIA, sulphured, covered.
> C—Exp. III, sulphured, uncovered.
> D—Exp. VII, sulphured vara, covered.
> E—Exp. IX, sea water, once washed, covered.
> F—Exp. X, Potassium meta-bisulphite.
> G—Exp. XIV, Sodium carbonate.
> H—Exp. XVA, Sodium hydroxide.
>
> The brokers stated that they had submitted the samples to a firm of oil crushers in London, who reported as follows:—
>
> We have received your letter of last month together with copies of letters to you from the Imperial Institute and also eight samples of Fiji copra. We have examined these samples and the analyses of them from the point of view of the crusher, and make the following observations:—
>
> Samples E and F are about equal to what we know as F.M.S. Plantation Fiji Copra.
>
> Sample C although high in oil content, has its value reduced on account of the very high percentage of F.F.As. in the oil, and this appears to be directly due to leaving it exposed and being uncovered at night.
>
> Of the other samples, D appears to be the most valuable on account of its high oil content.
>
> Samples A, B, G and H are deficient in oil, but are good from the point of view of F.F.As. in the oil and it may be only a coincidence that the low oil content and the low F.F.A. content exist together in these samples. We do not see why the preservative treatment should reduce the oil content of the copra.
>
> It appears to be important to protect the copra from rain and cover it at night, and the use of burning suphur as a preservative has a good effect."

### COMMENTS.

10. It is mentioned above that Samples A, B, G and H are deficient in oils. We have noted this (see Tables, Section II) as also have the Imperial Institute. It is probably due to the type of copra used, since Sample A above, which was untreated, was also low in oil. We agree with the remarks of the Oil Crushers that there appears to be no reason why the preservative treatment should reduce the oil content. May this also not be due to the fact that decomposition is so limited that we are here really dealing with actual oil content ?

11. In conclusion the remark of the Oil Crushers with regard to samples E and F " are about equal to what we know as F.M.S. Plantation Fiji Copra " gives some idea of the type of copra exported from Fiji. We considered these samples to be particularly bad, so much so, that we could not analyse them several months after preparation. It would appear from the remarks made by the Oil Crushers that distinct advances have been made with regard to the preparation of better quality material, having regard to the commercial aspect of the subject.

# AGRICULTURAL JOURNAL

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## EDITORIAL.

THE present issue completes the volume of the *Journal* for the year 1931. The financial provision in 1932 will only permit the publication of two issues, so that readers are requested to note that the 1932 volume will consist of two copies. An endeavour will be made to circulate information to agriculturists in Fiji by means of multigraphed notes.

*Fiji Show and Agricultural Conference.*—A comprehensive exhibit was staged by the Department on the occasion of the Fiji Show in October and attracted wide attention. Cinematograph films on agricultural subjects, loaned by the Imperial Institute, London, were displayed in the Health Department section of the Show by courtesy of the Health Exhibit Committee. It is interesting to record that the Show as a whole was very successful. The Fiji Show Association are to be congratulated on their decision to hold this function in spite of the difficult local conditions. It is noteworthy that in spite of the fact that there were no stock exhibits, the number of entries in all classes exceeded that of 1930. It is understood that the financial result is entirely satisfactory.

The Agricultural Conference was opened on October 13th by His Excellency the Governor. Meetings were well attended and keen interest was displayed in the subjects dealt with. A full report of the proceedings will be found in this number.

The Convention of Agricultural Associations was duly formed at an inaugural meeting of delegates on Tuesday, October 27th, 1931, when five out of the seven participating Associations were represented. The affairs of the Convention will be managed by an Executive Committee consisting of the Hon. Sir J. M. Hedstrom, the Hon. Alport Barker, E. Duncan, Esq., J. L. Hunt, Esq., and the Director of Agriculture. The Director of Agriculture was elected President of the Convention. His Excellency the Governor has been pleased to accord recognition to the Convention.

*Fruit exports.*—The output of bananas is rapidly increasing and in November 14,181 cases were shipped; 16,266 cases were exported during the period December 1st to 16th. The general improvement in quality has been maintained and this, with the more extended use of better cases, renders shipments more attractive than hitherto. Trials are in progress with a new type of case which while actually of smaller over-all cubic measurement contains the same, or a slightly greater quantity than the standard case at present used. A noteworthy feature of banana production is the increasing quantity now being shipped from outside districts such as Taveuni, Savusavu, Koro, Gau, Moala and Kadavu. The re-establishment of the banana industry in the Sigatoka Valley is proceeding and arrangements have been made to meet the cost of the suckers required by an advance from Government, the repayment of which is guaranteed from Provincial Funds. Similarly, in the Rewa River districts suckers will be provided for those who require them and payment made from the proceeds of the crop. Although the wider area over which the banana-growing industry is now spread renders transport and control of quality more difficult, there is the undoubted advantage that in the event of localised severe storms the output will not be affected to nearly so great an extent as was the case when the production was almost entirely confined to the Rewa River basin.

Referring to the subject of citrus exports which was discussed in *Journal* No. 2 of 1931, it is interesting to observe that Cyprus intends to explore the possibilities of exporting citrus fruits to New Zealand. In the *Cyprus Agricultural Journal* of September, 1931, reference is made to the substantial preference of about 7s. 4d. a case placed by New Zealand on oranges from Empire sources. The fact that a Dependency so far away from New Zealand as Cyprus is should be seriously considering the marketing of fruit in New Zealand should provide a stimulus to growers in Fiji, who are exceptionally favourably situated for that market. The Cyprus authorities are fully aware of the difficulties attending transport for so great a distance and they also have in mind the safeguards enforced by New Zealand against the introduction of fruit-fly. Now that it is known that the fruit-fly can be killed by exposing fruit to a low temperature, there is some prospect of easing the existing regulations. The Department of Agriculture, Cyprus, is apparently in communication with the New Zealand authorities on this subject.

## FIJI AGRICULTURAL CONFERENCE.

*October 13th and 14th*, 1931.

*Mr. Barnes*, in introducing His Excellency the Governor, said that this was the third occasion on which the Agricultural Conference had been held and that there were a number of interesting papers for discussion, including one new subject which had not hitherto been touched upon. He informed the gathering that last year the Organising Committee had been authorised to carry on its work with the object of endeavouring to form a Convention of Agricultural Associations, a central union as it were of country bodies, which could speak with authority on matters of agricultural interest, and a body which could be regarded by the Government as the channel through which matters of such interest could pass to and from the country districts. Mr. Barnes informed the Conference that the Committee had considered very carefully the requirements of such a body and formulated a draft set of rules which had been circulated, together with an explanatory letter, to the Organisations, both in Suva and the country districts. He intimated that the response had been most gratifying, seven of the Agricultural and similar Associations of the Colony had expressed a desire to become members of the Central Association. Continuing, Mr. Barnes remarked that this Conference would not deal with the work of the Central Association, but would be, as it were, an educational institution which afforded an opportunity of getting together to discuss matters of common interest. He said that His Excellency the Governor had taken a very keen interest in matters of this kind ever since his arrival in the Colony and that his presence to-day showed his continued interest in the objects for which the Conference had been called.

*His Excellency*, in rising to open the Conference, said that it gave him great pleasure to welcome on behalf of the Government those who had come to the Conference, and in particular those who had come from districts outside Suva. He said he would take the opportunity of thanking the Mayor for so kindly placing the Town Hall at disposal. He remarked that in particular he referred to the people who had come from outside Suva because he regarded it of the greatest importance in a Colony such as this where the Islands were so scattered and communication so difficult, that the people should get together for the discussion of common problems. Agriculture was the essential life of the Colony and therefore it was most important that the agricultural community should meet to consider matters which were continually before them. He remarked that the present day production questions had become extremely acute, and it was essential that the people should improve their methods if they were to market their produce in a better manner. He felt convinced that Fiji could do a lot more in that line and if the people were to do that more they were bound to get a favourable market. He said Fiji had the soil and the climate, and what were wanted were men who were willing to get down to hard work. His Excellency went on to say that the agricultural community must work together to get their goods on the market. He remarked that he had spoken before about Government assistance in planting and grading, and he hoped that the planting community would co-operate in connection with these matters. He did not suppose that Fiji could work up to a high reputation for its produce quickly, but if we could put oranges and other produce on the market with a Government guarantee behind them they were bound to find a good market. His Excellency remarked that copra was a product in which he had taken a very keen interest during the last year. He said he had been round the Western Pacific and had examined the copra produced and on his return had called in at Rotuma. He informed the Conference that steps had been taken in the Gilbert and Ellice Islands Colony definitely to prohibit the export of inferior copra. When he went to Rotuma last year he saw the worst copra which he had ever seen. He did not think that such bad copra could be made. Government had taken steps with the full co-operation of the people and the storekeepers, and had sent a Coconut Inspector for the special purpose of helping the people to produce a commodity of better quality. When he called at the Island this year he was astonished to see the extraordinary improvement brought about. His Excellency said that if the people of Fiji worked to a standard of the best and kept at that standard the produce would find a very much better market than it had at present. He remarked that the question of the grading of copra had been under consideration by the Government and that he was now awaiting a report from the Coconut Committee to whom he had referred the grading proposals. He noticed that there were two very interesting papers on the banana question on the Agenda of the Conference. During his visit to the Agricultural Show he had observed two banana cases. One cost less than 2d. more than the other, it was nicely planed and was a much better looking case. In the same way the packing of citrus fruits could be improved and more care taken in the preparation of the fruit for the market. He assumed the planting community that the Government would do all in its power to assist them. He thought that the Colony got very full value for the money which had been spent by the Agricultural Department. He regretted that the Government was unable to make a larger sum available for the extension of Experimental Stations to investigate the growing of plant material, pure line seed, &c. In this connection he wished to express the Government's thanks to Mr. Duncan who had very generously put at the disposal of the Government some land in Bua for the purpose of experimental work, but he was afraid that the present finances would not permit of any definite extension. Mr. Duncan's offer would be kept in view and he hoped that before long something would be accomplished in this direction. In conclusion His Excellency said that he hoped the points he had raised would be brought out during the discussions of the Conference.

*Mr. Hunt* read his paper " Banana Growing in Fiji " as follows:—

Banana growing in Fiji for some years past has not been considered as a planting proposition by Europeans. The duty imposed by Australia and the lack of good distribution at other markets caused the industry to dwindle to a notable extent.

Planters did not feel inclined to stand up to the extra expenditure of combating the borer and other pests when marketing facilities and distribution were not available so the wastage on European plantations was very great.

It would be well to call attention to the fluctuations which the banana industry has undergone since its inception. The first record dates back to 1877 when 3,100 bunches were exported. Eight years later this number had risen to 277,973 with a further rise by 1890 to 371,417. In 1892 the number was doubled, 799,210 bunches being exported and for many years this constituted a record. In 1893 the output had dropped to half and by 1895 had reached the low water mark of 155,474 bunches.

From this point a rise with fluctuations set in:—

| | |
|---|---|
| 1897 .. .. .. .. | 272,338 bunches. |
| 1900 .. .. .. .. | 488,690 ,, |
| 1902 .. .. .. .. | 424,993 ,, |
| 1905 .. .. .. .. | 313,829 ,, |
| 1910 .. .. .. .. | 433,524 ,, |
| 1911 .. .. .. .. | 1,328,670 ,, |
| 1917 .. .. .. . | 1,653,639 ,, |

which was the largest amount ever shipped from the Colony. In 1918 the quantity fell to 939,974, in 1919 to 520,038 and by 1930 to 165,000, almost as low as the record year of 1895. Duty to Australia was increased from 2s. to 8s. per case in 1921.

Although the importance to Fiji of the banana industry has suffered a severe set back by reason of the prohibitive duty involved on that fruit imported into Australia, the latent possibilities of these Islands in trade expansion for bananas and citrus fruits are such that it is difficult to estimate to what extent it will benefit the Colony when it comes into its own again.

Indications of a revival in the near future are bright. Since the hurricane and floods of 1929 and 1930 have swept Fiji, bananas are showing great promise and coconut planters who have been hard hit by low prices for copra are now planting bananas to a large extent and many others are seeking information as to planting, cultivation, pruning, powdering, cropping, &c., of this most valuable crop so the following may supply the information required.

There is no doubt the wet zone of Fiji is the most suitable for banana production. Planting distances are regulated by the quality of the soil. On rich banana land the distance for the Cavendish variety is 10 ft. by 10 ft. equal to 435 plants to the acre—a suitable distance, even 9 ft. by 9 ft. or less if it is not intended to replant the area: 10 ft. by 10 ft. and 9 ft. by 9 ft. allows of efficient working by implements.

For the tall varieties Veimama and Gros Michel 11 ft. by 11 ft., 12 ft. by 12 ft. and 14 ft. by 14 ft. (according to soil and intention of ultimate use of this soil) between rows allows of the interplanting of permanent trees such as coconuts, citrus fruits or tung oil which remain and reach the productive stage after the banana plantation has produced four to five years crops.

When good land has been well ploughed and cultivated or virgin bush felled and cleared, line out to the distance decided upon, dig holes 18 in. by 18 in. by 12 in. deep, even larger in virgin land and set the banana sucker or bulb on loose top soil in bottom of hole and fill up same to within three or four inches of the top. The filling of the hole to surface level does not take place until the stool is well and truly established and cultivation between the rows both ways has ceased.

The banana is a surface feeder and no matter how deep you plant the original bulb the stool always works upwards.

To plant deep to obtain better resistance against high winds does not materially assist as the stool gradually rises; but if planted in good friable soil the roots soon penetrate and the stool obtains a very solid grip.

Drainage must be good and efficient. Bananas can stand a heavy rainfall but not wet roots.

The best months to plant are August, September, October, and November. Care must be taken in the selection of plants. The sword or spike suckers are preferred, their leaves are just forming long and narrow and from 2 ft. to 3 ft. high with good bulb-like butts or corms. Examine carefully to see that they are clean and free from borer.

On a well conducted banana plantation nurseries are established yearly of sufficient extent to provide plants for whatever area has to be planted yearly. These nurseries should be planted out in January when selected plants and stock from them will be ready for planting out in the following August and onwards. In this way there is less risk of borer than there would be if plants are taken from old plantations.

It is advisable to dig out the whole stool from the nursery, divide up and discard any weak looking or leafy suckers and four plants at least should be available from each stool at 7 months old. It would be well to steep all plants before planting into nurseries as directed by Mr. Simmonds as one would then be certain of obtaining plants free of borer.

To obtain good bunches it is necessary to prune, that is remove certain shoots or followers from the parent plant, not by careless digging but by cutting them well under the surface without damaging the parent plant and unless special tools are used, stab the centre of the bulb or corm removed making a circular movement in doing so. An implement, the patented invention of Mr. Chave Morrison, somewhat similar to a small post digging auger was used here when bananas were plentiful and was an excellent tool for pruning purposes. It is unnecessary to prune till parent plant is six months old, or seven months old, unless growth has been excessive. Experience will teach you which suckers to remove. Weak suckers are distinguishable by their poor looks, slender, long and leafy. A good sucker or follower has a nice full round bulb at the butt and tapers to a sharp point before throwing leaves. The most to be left round parent plant would be three and those must be the best, both as regards position round the parent, and age as regards rotation of throwing bunches. Where growth of parent and followers is very strong it is sufficient in first pruning to leave only two followers.

It has been found very difficult in Fiji to prune so as to have stools fruiting when market prices are high, especially with Gros Michels as their natural months for carrying the flush of fruit are January, February and March, and this variety is liable to be killed out by pruning to get it to produce mature fruit in August and September. The Cavendish and Veimama, if properly pruned will carry fruit all the year round, but take longer to mature in the winter months; as the temperature rises, so does the crop improve. In the cool months a period of sixteen weeks elapses between the shooting of the " flower " to the time the bunch is cut, where in the height of summer that period is ten weeks only.

In 9 to 12 months' time under ordinary favourable conditions, the plants of the Cavendish variety are full grown and the flower shoots. Two and a half to three and a half months afterwards the bunch is ready to cut for shipment, three quarters full or slightly over that stage.

When the plantation has reached the bearing stage the flowers or " sobos " start to shoot and these have to be attended to immediately the flower leaves the vertical and is becoming pendant. The man who has charge of the cleaning and powdering must be expert at his work. He starts from the top and removes carefully the sheath covering each hand and keeps on working downwards till he comes to hands which would be too small when ready for market; below this he removes both sheath and hand for several hands and then leaves the balance at end of stalk or stem.

The bunch is then efficiently powdered with insecticide blown in all over the hands and between the fingers to keep off insects, thrips and other pests that immediately attack the bunch.

This cleaning and powdering must be carefully and efficiently done otherwise the whole crop might be ruined, and having brought a plantation to the bearing stage it is well to see that not a bunch is lost so that the maximum return is obtained. The insecticide is one part Pryethrum Roseum and three parts of selected white sifted wood ashes carefully mixed together.

Too much of this mixture should not be made up at a time. Mix only sufficient to do one or two days' work and keep in a closed tin after mixing. It is well on the next day again to look over the flowers or bunches, especially in wet weather. There are many men in Fiji that are quite expert at this work and can efficiently clean up to 120 flowers per day, but it is not advisable to give a cleaner piecework.

The cost of bringing an acre of bananas into bearing without counting the proportionate cost of the planter's house or his upkeep during the period, that is, from the time of clearing the ground and planting till the crop is reaped is £13 to £18 per acre according to the country operated on.

In Fiji the first or plant crop will come into bearing on good soil in 12 months. Marketable bunches have nine hands or over and where the fruit is shipped on the stalk, bunches under nine hands are broken up into hands or fingers as the market requires and the fruit is shipped in cases; the 3-feet double case for New Zealand and the bushel case for the Commonwealth of Australia.

A 3-feet case properly packed in single fingers contains from 80 to 85 ℔ weight of fruit, and a bushel case if the hands packed therein are not too large, about the same.

An acre of bananas on good soil and free from disease should produce within 15 or 16 months at least one bunch to a stool or plant set out. These figures are conservative but a blow might more or less seriously alter expectations.

The profitable life of a healthy plantation should run from one of plant crop and three or four years of ratoons and on a well organised plantation it is well to replant one-fourth or one-fifth every year so as to keep up regular output.

Under present methods of cultivation it is considered that one man can look after five acres, and one should expect to receive on the plantation from 1s. 6d. to 2s. 6d. per bunch and from 3s. to 5s. per case or even 6s.

The Australian market could absorb enormous quantities of bananas from Fiji if distribution were properly organised. The New Zealand market, although limited, is a growing one, but here again there is scope for large extension, provided transport and handling are cheap and distribution is widened and extended.

Another very large market to be explored is Canada, and the establishment of direct communication with Fiji would be an arrangement mutually beneficial to this Colony and to the Dominion and everything possible should be done to secure it.

To assist the industry it is vital and necessary that freight charges should be reasonable. The present charge of 4s. per case freight from Suva to Auckland will seriously cripple a reviving industry.

*Mr. Simmonds* read his paper " Pests and Diseases of the Banana in Fiji " as follows:—

Before proceeding to discuss the actual diseases attacking bananas in Fiji I would like to call your attention to the big fluctuations in output of this crop that have occurred since the fruit was first exported. Mr. Hunt has given figures showing how, starting with 3,100 bunches in 1877, the industry had expanded in 15 years to just on 800,000 and then in three more years had fallen to the record low crop of 155,000 bunches. So far as I have been able to ascertain this sudden fall was brought about by two causes, a disastrous flood in the Rewa, followed by a severe outbreak of bunchy top in Tailevu.

2. In 1911 another big fluctuation occurred, when the quantity rose from 433,000 to 1,300,000, due to the opening up of large areas on the Rewa. Six years later, the record output of 1,653,000 bunches was reached, which fell, owing to the influenza outbreak, to under the million the following year. This was followed by the Australian strikes and then the duty, leading to the present low figure, and incidentally, to the disappearance, only temporarily it is hoped, of the European grower.

3. Whilst the duties imposed upon Fijian fruit by the Australian Government in 1921 destroyed any hope of the trade recovering the position it held in that market in 1917, the high quality of the bananas shipped from Fiji had won such a good name, that it seems probable that if this country is again able to supply bunch fruit of that grade, it should, despite the duty, be possible still to send a certain quantity profitably to that market.

4. I now propose to consider what were the factors which had put the European grower out of practice and placed the country in the position of being unable to supply either the quantity, or quality, formerly exported. Apart from the closing of the Australian market by a tariff, there is no doubt that irregular and infrequent shipping were the most serious individual difficulties that growers had to contend with. Unless growers have at least a two-weekly service they suffer serious losses due to fruit passing the shipping stage between boats. On the other hand, unless a certain quantity of fruit is available it does not pay shipping to call, so that, when production falls below a certain critical point, the grower has to face further losses due to insufficiently frequent shipping.

5. At the same time the speaker is of opinion that the main factor leading to the abandonment of cultivation by Europeans was the appearance of certain diseases, some undoubtedly introduced, while others first recorded in Fiji may have been of local origin. Of these diseases there are three that stand out prominently, the earliest to appear being bunchy top. This was followed by the introduction, at an unknown date, of the borer *Cosmopolites sordidus* and, about 1913, the obscure condition known as Sigatoka disease, made its appearance. Of these troubles the most universal and disastrous was, in the speaker's opinion, the borer and much of the trouble blamed to the last named disease was probably due, directly or indirectly to this insect. Now that a method has been evolved of dealing with the borer pest it appears that there is again an opening for the European grower and by the use of the careful methods possible under estate conditions, a possibility of not only increasing our present shipments to the New Zealand market, but of also obtaining a profitable return for a percentage of our highest grade fruit in the Australian and Canadian fields.

6. I will now review the diseases of the plant in Fiji, particularly those which have contributed so seriously in bringing about the present low output and describe some experiments carried out by the Department which encourage the hope that the time has now come when it should again be profitable to take up the planting of this crop. It will be noticed that low as the output of 1930 was, it was not so low as that of 1895, only three years after the big export of 800,000 cases. That was, as stated earlier, due to bunchy top and the recovery from that disaster is encouragement that Fiji bananas may again recover from the cumulative effects of borer, Sigatoka disease and shipping troubles.

### BUNCHY TOP.

7. This is the oldest disease of bananas in Fiji and, at the time of its appearance, had not been recorded from elsewhere. It reached its maximum about 1894–5, but had been present probably since as far back as 1885. In 1913 the disease appeared in Queensland, it is said having been imported from this country. It was undoubtedly taken from Fiji to Wallis Island and more recently has been reported from Ceylon. Whether the Ceylon disease is identical is as yet uncertain.

8. The origin of the disease in Fiji is very obscure. It has been suggested that it was originally a sugar cane disease which, in Fiji, moved over to bananas. There is, however, no evidence to support this suggestion. A more probable suggestion is that it was imported with an immune strain of suckers about 1885 and then rapidly spread through the non-immune plants. Such importations are known to have taken place about that date from Tanna and elsewhere.

9. *Symptoms.*—The disease is characterised by rosetting or proliferation of the foliage. The leaves become small, erect, brittle and dark in colour and in well-marked cases the plant produces no fruit.

10. *Cause.*—The causal organism is unknown, but the disease, which belongs to the class known as " virus diseases " has been proved to be transmitted from plant to plant through the agency of an aphis, *Pentalonia* sp. Whilst this is the only insect at present known to be capable of spreading the disease it is possible that other sucking insects, such as *Lyricen* sp. may be proved able to do so. The aphis is not easily found as it generally lives inside the bases of the leaves and similar sheltered situations. Its control by any method of spraying is thus rendered very difficult.

11. *Bunchy top control.*—At the present time bunchy top in Fiji cannot be said to cause very great losses, and the plants seem to possess a considerable degree of resistance or immunity.* Growers are advised to destroy immediately any plant observed to be affected. Before doing this a small quantity of kerosene or kerosene emulsion should be poured into the heart of the plant to kill as many aphis as possible, thus prevent their flying to other plants, and so spreading the disease, and then to dig up the whole and burn it, or dump it out to sea.

### NEMATODES.

12. Banana roots in the old experimental station at Nasinu and elsewhere have been found to suffer severely from a species of nematode worm, *Tylenchus* sp. Attacks by this worm lead to a good deal of rot in the small rootlets, allow the introduction of fungi and have been connected with the so-called Sigatoka disease.

### BANANA SCAB MOTH (*Nacoleia octosema.*)

13. The larvæ of this moth cause the unsightly scabs often observed upon bananas in this country. The insect is also known from Java, Queensland and Samoa.

14. *Life history.*—*Egg.*—The eggs are laid in small clusters on the back of the small leaf which encloses the shooting spike or on the surface or base of one of the surrounding leaves. They are extremely flattened and very minute, so that a cluster of 9 or 10 eggs has the appearance of a light brown scale, perhaps ⅛ inch across. The eggs are deposited about the time that the bunch is being thrown, seldom later. The incubation period is very short—about 72 hours—and the young larvæ will be found to have already entered the spike by the time that this has reached the horizontal position.

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* It has been found that a small percentage (5–7 per cent.) of plants subjected to the soaking treatment for borer throw bunchy suckers from the eyes, suggesting that the disease is present but latent and that the severe shock of the treatment caused it to develope.

They do this, not by boring in, but by entry at the tip, where the sheath is uncoiling. For this reason they generally reach the terminal hands first and, fortunately, the larger basal hands are less frequently attacked.

15. *Larva.*—The larva is a dirty pinkish caterpillar which feeds between the fingers, generally upon the outer surface, but frequently, when two-thirds grown entering the green fruit and hollowing it out. They make the fruit into a disgusting mess with accumulations of frass, and render it commercially useless, owing to the disfiguring scars where the larvæ have fed.

16. *The pupa.*—The larva spins a frail cocoon, generally between two fingers, within which it pupates. The pupa is light brown in colour and about ⅝ inch in length.

17. *The adult.*—The adult moth is pale dirty yellow in colour with a few black spots and lines. It is nocturnal in its habits.

18. *Natural enemies.*—In Fiji a single specimen of a Braconid parasite was once bred out of a larva by the speaker, whilst a pupal parasitism of 20 per cent. by a smoky winged Chalcid has been occasionally obtained.

19. Two parasites have been recorded from Queensland, both apparently casual. Some years ago also Leefmans bred a Braconid in Java, from the carva, but the speaker reared upwards of 500 of the moth from various Javannese sources and failed to recover it, so that, this also, is probably only a casual enemy of the pest. In Fiji egg clusters have been found which have been eaten, possibly by an earwig or ladybird.

20. *Artificial control.*—At present the only method of control known is to strip the bunch as early as possible of its bracts, open up the hands and fingers, blowing a mixture of pyrethrum powder and wood ashes (in the proportion of 1–3 in summer and 1–2 in winter) between the fingers. This method is only partially efficient, partly because a good deal of damage is already done before it is possible to clean the bunch and also owing to the difficulty of reaching all parts of the hands. The pyrethrum too is variable in quality and consequently in its action.

21. As the eggs are laid openly it is possible that in the future this may be found the most vulnerable point of attack. Egg parasites may be found; such, however, frequently have very slow powers of dispersal. It may, however, prove possible to train boys to search for the eggs and remove them before they have time to hatch until such time as experiments which are being carried out evolve a spray which will destroy those present and prevent further deposits. In this case all chances of damage to the fruit would be removed.

### THRIPS.

22. There is in Fiji a small flower-haunting thrips which may cause a certain amount of corking of the surface of fruits. Its damage is, however, negligible.

### FRECKLES.

23. There is in Hawaii a disease of the skin of bananas called freckles, which principally attacks the Cavendish variety. On Taveuni the speaker has seen a number of bunches of this variety showing a dense spotting rather recalling the disease freckles. It does not affect the quality, but only the appearance of the fruit and, up to the present, no work has, in this country, been done upon it.

### SIGATOKA DISEASE.

24. The obscure condition known as Sigatoka disease was characterised by a tapering of the head of the plant and premature throwing of the fruit. The bunch was undersized, with small fruit, which ripened prematurely upon being cut. It first appeared in the Sigatoka district and about 1913 seems to have been present on the Rewa. Whether the condition still exists in

the Colony is uncertain, but none has been reported for the past three or four years.

25. Whilst there is little doubt that in a large number of cases what was called Sigatoka disease was really due to severe borer attack, the speaker did see in 1923, in the Sigatoka Valley, certain Gros Michel plants, tapering abruptly and throwing their bunches prematurely which, upon examination were found not to be suffering severely from borer or other maicroscopic disease. Like Panama disease, it was the Gros Michel which suffered most severely, the Cavendish showing some resistance from the first. With the almost total disappearance of the Gros Michel the condition seems to have died out and, at the present time, no complaints of premature ripening are being received.

### SCALE (*Aspidiotus destructor.*)

26. When this pest first appeared in Fiji it was bananas which suffered most, subsequently, however, coconuts were more heavily attacked and the damage to bananas was not often great. It did, however, lead to compulsory fumigation of all export fruit for Australia, thus imposing additional expense upon shippers.

27. *Control.*—During the early ravages of the pest, and whilst it was still practically confined to bananas, control efforts took the form of spraying with lime sulphur, but with the spread of the insect to coconuts this ceased to be practicable and a number of natural enemies were imported by the Department of Agriculture in order to bring about biological control, very successful results being obtained.

28. In the course of this work six or seven internal parasites were introduced from Tahiti and Java and some six predatory ladybirds from Java and Trinidad. One of these *Cryptognatha nodiceps* from Trinidad has proved most highly efficient and generally speaking this scale causes little anxiety at the present time.

29. Several other scales have been reported from bananas in Fiji, none, however, have been found to be commercially important.

### SMALL BANANA WEEVIL (*Polytusmelber borgi.*)

30. This little weevil is almost an exact miniature of the banana borer *Cosmopolites sordidus*, to be discussed next, but is different in its habits,being generally found in the stem of the plant instead of the roots, whilst the early stages seem to be still unknown. In any case it is of no importance as a pest.

### BANANA ROOT BORER (*Cosmopolites sordidus.*)

31. An Indian school master recently wrote to the speaker as follows: " The banana root borer is the worst pest of bananas known. Give the life history of the insect and a method of reducing its numbers in the plants." There is little doubt that this statement describes the position in Fiji and in the speaker's opinion, if the borer could be controlled, all the other banana troubles would sink to very minor proportions.

32. *Effect of borer.*—The borer affects the plant in various ways:—

(1) directly by reducing the size of the bunches. These instead of ranging from 10 to 12 hands fall to 6 or 8 only and such of inferior quality;

(2) also directly by shortening the life of the estate, reducing it so that at 2½ or 3 years it has the worn-out appearance expected in an old estate of a 5, 7 or even older cultivation.

33. There is also little doubt that it has an indirect effect, weakening the plant, causing it to fall over in high winds and allowing the introduction of fungus and other disease.

34. The pest is now widely distributed, being found in Java and through the Islands to New Guinea and Queensland, also in the West Indies, most of the Pacific Islands and Natál. Everywhere it has caused serious loss to planters and much thought has been given to methods for its control. Special entomologists have been working on it as a full-time job for some years.

35. *Life history.*—The white oval egg is laid in a groove in the corm of the plant at or just above the surface of the soil and is most difficult to detect. The resulting grub tunnels through the corm, occasionally, in young suckers, attacking the growing eye and causing the death of the plant. This tunnel gradually enlarges as the grub grows and is packed with the frass (excreta) of the grub. When full fed the larva makes its way towards the surface of the corm, but leaves a thin outer section, pupating without forming a cocoon. When, after 10 to 14 days, the adult beetle is ready to emerge it breaks through the thin outer section of the corm and so reaches the surface. It will thus be seen that during the greater portion of its life, the beetle lives within and protected by the corm with only the tiniest connection with the outer air. This renders any method of treatment most difficult, as in the very limited air circulation, no dip or fumigant can, at normal pressure, reach the grub except in a highly diluted condition. In view of this difficulty, efforts were first directed towards some biological method of control and, in 1913, the predatory beetle *Plaesius javanus* was successfully introduced from Java by Jepson. Although successfully introduced the beetle did not bring about any appreciable measure of relief and further work on the subject became necessary. From the end of 1926 up to 1929 a number of experiments were undertaken by the speaker which have been detailed elsewhere. These showed that:—

(1) whilst flight took place occasionally, it was so seldom that, as a factor in the spread of the pest, it was negligible;

(2) that the beetle crawled from one plant to another, but even this as a factor in the spread of the pest was not so rapid as usually thought to be the case, clean plants placed alongside heavily infected ones in several cases remaining clean at the end of 12 months.

36. This indicated that infection is almost always due to the presence of eggs or larvæ in the suckers used in establishing a new estate and if clean suckers could be obtained by some method of treatment, it should be possible to plant up land away from any old stools with confidence that the planter would reap a full harvest before the borer entered in sufficient numbers to do appreciable damage. Efforts have therefore been directed towards endeavouring to obtain a method of ensuring that the plants to be used in planting up should be clean, even though derived from infected sources.

37. First experiments were directed towards some fumigation method, carrying the fumigant (in this case carbon di-sulphide) into the borings by creating a vacuum and then releasing the poison. Whilst a considerable measure of success was attained by this method, there were some survivors even at the point when the plants were killed whilst it was doubtful if eggs would be hurt at all.

38. The next series of tests involved soaking the plants for varying periods and at various depths in cold water and by using the method detailed below it was found possible to obtain a full 100 per cent. mortality of borer without irreparable injury to the plant:—

(1) Good strong suckers must be selected, having one or more undeveloped lateral eyes in addition to the aerial stem.

(2) These suckers are placed in a tub, punt or other water-tight vessel, with the aerial stem upwards.
(3) They are then covered with fresh water to a depth of about two inches above the point where the stem joins the corm, leaving the aerial stem fully exposed to the air and light.
(4) They are left for 21 days, taking care that the water is maintained during the whole of that period at the same level. This is most important.
(5) After 21 days they are removed and planted out, either in an isolated nursery or in the field.
(6) It will then be found that they die back to the corm and one of the lateral eyes develops, producing, in 12 months, a bigger and better bunch than would have been the result had the sucker itself grown.

39. In conclusion a few remarks on the relative merits of the different commercial varieties of bananas may prove of interest as the question is often asked " What is the best variety of banana to grow ? "

40. There are only three commercial varieties in Fiji, viz., Gros Michel, Veimama and Cavendish. In the West Indies some attention has been given to another variety, Lacatan, and the notes on that fruit are from Wardlaw and McGuire's paper on " Cold Storage of Bananas."

### GROS MICHEL.

| *Advantages.* | *Disadvantages.* |
|---|---|
| Not easily damaged in packing. | Very subject to diseases, such as Sigatoka and Panama. |
| Favourite in America. | Slow coming into bearing. |
| Hands widely separated. | Liable to damage by hurricane. |
| Good colour. | Flavour of fruit second class. |
| | Difficult to clean bunches. |

### VEIMAMA.

| | |
|---|---|
| Resistant to disease. | Fruit coarse. |
| Good carrying fruit. | Intermediate in coming into bearing. |
| Large bunches. | More liable to hurricane damage then Cavendish. |

### CAVENDISH.

| | |
|---|---|
| Fruit superior, flavour first. | Fruit requires care in packing. |
| Early fruiting. | Hands close together, so liable to damage in cleaning. |
| Large number to acre. | |
| Disease resistant. | |
| Least liable to hurricane damage. | |
| Easy to clean bunches. | |
| Favourite in Great Britain, Australia and New Zealand. | |
| Good colour, but paler than Gros Michel. | |

### LACATAN.

| | |
|---|---|
| Resistant to disease. | This fruit is not present in Fiji. |
| Good flavour, first grade, and texture. | Shallow rooting. |
| | Unsatisfactory ripening. |
| | Frequently poor colour. |
| | Very easily damaged. |

41. It will thus be seen that in a Group like Fiji, subject to hurricanes, the Cavendish has very great advantages over the other commercial varieties, but the fruit requires more careful handling than either Gros Michel or Veimama.

*Addenda.*—Since this paper was written further work has been done and certain information on bunchy top come to hand, and it is considered advisable to add this now.

*Origin of bunchy-top.*—Whilst this disease was first recorded from Fiji, there is evidence to show that it was originally imported from elsewhere, probably on an immune strain. The earliest record I now have is 1886 on an estate close to Suva, following an importation of plants, it is thought from Tanna in the New Hebrides. It completely destroyed the estate in a very few months.

*Banana Scab Moth* (*Nacoleia octasema*).—Further work has shown that the egg clusters are placed, not only on the small leaf, but upon any of the leaves surrounding the shooting spike and on either surface or at the base, but only whilst the spike is being shot, so far as has at present been observed.

*Mr. Witherow*, in opening the discussion, said that both Mr. Hunt and Mr. Simmonds had read very interesting papers. Although both the above gentlemen had spoken so optimistically of the industry he was afraid that he must take a more pessimistic view. He said that he would touch on two aspects only—markets and shipping facilities. He remarked that at the present there was only one market to which Fiji could ship bananas and that was Auckland, New Zealand. This market was being supplied with fruit from Fiji, Samoa, Raratonga, the Cook Islands, Norfolk Island and Niue Island, and even Australia was shipping bananas to New Zealand. He understood that shortly there was going to be a direct service from Tonga to Auckland to carry fruit which was now being grown there. He said that if things had been normal in Fiji and we had shipped the usual 15,000 or 20,000 bunches of bananas monthly it would have been disastrous for the shippers. Even with the small shipments which had been made the losses had been serious. Mr. Witherow said that the time had arrived when we must look for another market and the only market that he could see available outside of New Zealand was the Canadian market. Canada, in his opinion, was an important market for all Fiji produce. Mr. Witherow remarked that some years ago a trial shipment of bananas was sent to Vancouver. They were shipped in cold storage and took 28 days on the voyage. Bunches realised an average of 15s. per bunch and the shippers received an excellent profit. His contention was that if bananas would carry for 28 days under such adverse conditions they should carry in good order and condition in proper ventilated ships. At the present time he said there was one ship, the "Tofua," carrying bananas to Auckland and he contended that she was unsuitable for the trade. The "Tofua" took about five days to do the trip to Auckland which should be done in about three days, and invariably arrived with a very large percentage of the fruit ripe or over-ripe which was a big loss to the shippers. He remarked that the "Tofua" had four boilers, but although representations had been made by the shippers personally and also by the Fiji Planters' Association that the fourth boiler should be used, the Union Company had refused to comply with this request, with the result that the fruit was at least 24 hours longer on the voyage than was necessary. He remarked that what was required was a well-ventilated ship running three-weekly services. The four-weekly service was far too long between shipments, especially during the hot months of the year, and resulted in a great loss to the native grower, who every trip picked a lot of immature fruit because he knew that if the fruit stayed on the trees for another four weeks it would be useless. With a three-weekly service we could ship a good grade of fruit all the year round. Mr. Witherow remarked that Mr. Hunt in his paper had said that there were indications of a great revival in the banana industry. Mr. Witherow said that he could not see eye to eye with him unless a new market was found for the fruit. The New Zealand market was being overdone, shippers would not ship to New Zealand unless they could make a profit. Years ago when Fiji had an extra market in Australia for the fruit, Europeans had thousands of acres under bananas in Vitilevu. To-day he considered that he was quite safe in saying that there was not more than 50 acres under banana cultivation by Europeans. Mr. Witherow concluded by saying that there would be no big revival of the banana industry in spite of the excellent paper which had been read about the control of disease by Mr. Simmonds, until a fresh market had been found for the fruit.

*Mr. Barker* said that when he was in Vancouver he was taken by the Managing Director of a Cold Storage plant over the works and that there was lying at the wharf a British ship which had been used for carrying bananas from Brazil to London. The voyage took 16 days. Mr. Barker stated that his friend said Fiji bananas could be easily carried to Vancouver and his firm would be prepared to market the bananas not only in Vancouver but also in other places of Western Canada. The railway lines of the C.P.R. and C.N.R. ran to the cool storage rooms so that there would be no difficulty about transporting the bananas from there to any part of Western Canada. He remarked that he thought this should be taken up by the Government. Mr. Barker informed the Conference that this particular firm was willing to put on a shipping service, provided freights could be guaranteed.

*Mr. Barnes* said that the discussion on the papers had been very short, but very much to the point and that he was particularly interested in the matter raised by Mr. Barker as he had been exploring the possibilities of marketing Fiji produce in Canada. The speaker said that he did not share the pessimism expressed by Mr. Witherow. He had already said that new markets were wanted for Fiji produce and if the people were prepared to supply what was wanted at the price which the people could pay there would be no trouble in finding the markets. Mr. Barnes entirely agreed with Mr. Witherow that the banana shippers had had a thin time. Unfortunately the prices were fixed rather too high, which was a disadvantage from the shippers' point of view. It had been found necessary to call more frequent meetings of the Banana Licence Board which now met from month to month, and in this way was able to pay closer regard to the shippers' and producers' interests. The Fiji banana stood very high in the opinion of the people of New Zealand and they were always prepared to take Fiji bananas in preference to bananas from other places. Mr. Barnes called attention to Mr. Witherow's remark about the Auckland market being over-supplied. There were other towns in the North Island of New Zealand and even in the South Island which had not been touched as far as the marketing of Fiji bananas was concerned. A return of £7 or £8 nett profit per acre as quoted by Mr. Hunt he considered was sufficiently attractive to encourage more people to take up the cultivation of bananas. One important point which had been overlooked during the discussion was the development of a trade in dried bananas. He stated that inquiries had been received and he shortly hoped to make an announcement about this matter not only with regard to bananas but also the likelihood of marketing fresh pineapples.

*Mr. Matthews* drew attention to the fact that about twelve months ago in Auckland bananas were being retailed at 8d. to 1s. per dozen.

*Major Willoughby Tottenham* raised a point in connection with the railway freight on bananas in New Zealand. He said that he understood the Fiji bananas were charged at a much higher rate than New Zealand fruit railed from town to town.

*Mr. Witherow* said that he would like to supplement his remarks by stating that the freight on bananas to New Zealand was 4s. per case, a voyage of 1,200 miles. This freight worked out at about £4 per ton, which he thought was the dearest freight in the world.

*Mr. Mander* called attention to Mr. Witherow's remarks about the unsuitability of the " Tofua " for carrying bananas. He remarked that the " Tofua " had been carrying bananas for the last 20 years and from records in his office it was evident that the shipments arrived in Auckland in good condition. With regard to the freight on bananas Mr. Mander said that during the last ten months his Company had lost £12,000 on the running of the " Tofua."

*Mr. Fernandez* said that the information given about the freight on bananas from Fiji to Auckland was very interesting and quoted the fact that the Rewa Co-operative Dairy Company Limited paid 3s. 9d. per box freight on butter from Suva to Auckland, whereas from Auckland to London the freight was only 3s. 6d. He said that about eight or ten years ago the freight from Suva to Auckland was 1s. 10d. per case.

*Mr. Hathaway* spoke about the improvement of banana cases.

*His Excellency* said that all had listened with much interest to the papers of Mr. Hunt and Mr. Simmonds and the discussions had been very illuminating. He said that he was pleased to hear a little pessimism from Mr. Witherow which he was certain could be overcome. The question of new markets had been continually before the Government for sometime past and last year arrangements had been made for the Director of Agriculture to attend a Conference at Honolulu which was, however, postponed. Government would consider asking him to go further afield to investigate markets for Fiji produce. His Excellency mentioned Jamaica which had been properly organised and now had ships running to London with fruit. The Shipping Companies were passing through a particularly difficult time and they required our sympathy just as much as the planting community did. In conclusion His Excellency thanked Mr. Hunt and Mr. Simmonds for their very useful papers.

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*Mr. Turbet* read his paper " The Stock Industry with reference to the Export of Beef " as follows:—

For many years the growing cattle industry of Fiji has lanquished for want of sufficient markets in which to dispose of our inevitable increase. The future development of our beef cattle raising industry is thus dependent on the establishment of an overseas market. There appear to be prospects of such a market in Hawaii, part of the territory of the United States of America and also on the mainland of the United States. With a view to sharing in this market an effort was made by a local breeder about two years ago to arrange for a shipment of carcase beef to United States territory. He had not, however, ascertained the conditions governing the importation of meat into the United States and at the last minute it was found that the United States territories would not accept meat from Fiji, this country not being included in the list of countries from which meat could be imported.

The United States Secretary for Agriculture has ruled that no meat or meat products shall be imported into the United States from any country which does not maintain a system of meat inspection which is substantially equivalent to that of the United States, and, further, that meat and meat-food products are ineligible for importation into the United States under the present regulations of Fiji as they do not provide for veterinary ante-mortem and post-mortem inspection, the disposal of diseased meat, the re-inspection of meat and meat-food products, labelling, the use of preservatives and dyes and adequate sanitation.

In view of this ruling it became apparent that if Fiji wished to export meat she must be furnished with adequate regulations. Now, the United States regulations are contained in a substantial volume of over 100 pages, and at first sight it would appear an impossible task to draw up regulations substantially equivalent to those of the United States without producing something almost equally voluminous.

The regulations of the Central Board of Health had already been submitted to the United States authorities and turned down, and to patch these up to meet the requirements of the United States would have been comparable to the solving of a very difficult cross-word puzzle. As a guide therefore recourse was made to the Meat Export Regulations of the Commonwealth of Australia. As the title signifies they deal expressly with the export of meat and we know them to be acceptable to the United States authorities. With few modifications these regulations have been adapted to our requirements. They are too voluminous to read through now, but I understand that those interested will have an opportunity of perusing the draft regulations.

In support of the title of this paper I would now put before you my ideas of the essentials for successful meat export.

*Quality.*—Methods of slaughter, dressing of the carcase and transportation have an important bearing on quality. These factors are immediately controllable and can be thus altered to effect improvement at any time—more difficult factors to control are uniformity of type and early maturity. These take years of careful breeding. Good feeding is essential to the production of exportable beef.

It is generally accepted that Fiji is unusually well suited to the production of beef cattle. This is manifested by the quality and size of our cattle. People who have travelled widely say that they more than compare with cattle of other tropical countries. The average dressed weight of cattle slaughtered in the Philippines, for instance, is 110 kilos, equal to 242 lb as compared with 550 lb in Fiji. There is little difference in fact between the average beef cattle of Fiji and those of New Zealand or Australia.

The above remarks, of course, refer only to cattle actually slaughtered, but since the potential production in Fiji is considerably greater than the demand for local consumpton, only the best of the beef cattle supply finds its way to the registered slaughter-houses. There are many more cattle unfit for slaughter owing to poor condition. Lack of condition or quality in Fiji cattle is as a rule not due so much to bad breeding as bad feeding. This latter fault is more the result of overstocking than actual poorness of pasture. Lack of markets in many districts, particularly Taveuni and Vanualevu, has prevented owners from disposing of their natural increase, resulting in many instances in overstocking of available pasture. The animals held on many of these properties would thus not be immediately available for export. The export beef would come from more conveniently situated river-flat pastures which have not been overstocked. A more rapid turnover of these stock should result. The remoter cattle breeders might then commence to find a more ready local market in filling the gaps caused by the slaughter for export of cattle from those lands more conveniently situated.

The class of cattle required by America is tending more and more to that referred to as "baby beef," which is generally killed between one year and two years old, weighing (live weight) up to 1,100 lb. These animals are the progeny of early maturing stock, raised on the mother and, after weaning, fed with concentrates so that the growth and fattening has been unchecked. The beef cattle raising industry in this country is not yet sufficiently developed to produce "baby beef." The best that can be produced are steers, castrated early, raised with their mothers and grazed on good river-flat pastures not overstocked, so that they reach their prime at about five years old without any setback.

This is the only class of beef which should be considered for export and would be unacceptable unless fat, of uniform size and good conformation. The conformation should be uniform throughout the carcases of any particular shipment so that there is no disparity for instance between sizes of fore and hind quarters. When hung for inspection for purchase at their destination they should appear as neat and trim as a line of well sized and dressed soldiers.

The meat from such beasts would be, I am sure, acceptable to the American public. It would, however, be fatal to future trade to ship carcases of mixed sizes, conformation and inferior quality.

The carcase from the large, long-legged, big-framed, aged bullock is not popular in America. The greatest demand is for beef in the retail trade and American housewives are very judicious in this matter, requiring a small family joint which must be of good quality. The types of cattle producing meat of this class are plentiful in the United States of America and exporting countries have made some advancement towards the production of early maturing beef suitable for export, mainly by the importation and use of bulls of early maturing strains.

When stock are held too long in transit or at the slaughter-house paddocks on poor feed before slaughter, there is a resulting loss of condition at the last moment, reflecting in the quality and weight of the carcase. Care should also be taken to avoid knocking and bruising—in this respect the suitability of hornless cattle for the export market is noteworthy.

Beef cattle intended for export should be quiet and accustomed to being driven. They should be handled quietly and capably to prevent restlessness, injury and subsequent loss of condition.

On arrival at the slaughter-house after a tedious journey cattle should be rested in good paddocks for 24 hours prior to slaughter. If the weather is hot, cold shower baths immediately before slaughter improves the meat.

In bleeding, sufficient time should be allowed for proper bleeding. If this point is neglected the meat is subject to earlier deterioration from putrefactive processes owing to the veins containing blood clots.

The spinal column must be sawn, not chopped, in dividing the carcase.

Avoid the excessive use of water on the carcase; a warm, damp cloth should be used for wiping down.

*Supply.*—It is recommended that with a view to the export trade intending exporters should, wherever possible, set aside some of their better class land for the sole production of export beef, care being taken not to spoil the potential productivity of the soil by overstocking.

A continuity of supply in the event of the export of meat being attempted is necessary to keep Fiji beef before the public of the importing country in order to obtain the readiest sale and best prices.

Although Fiji has a comparatively large cattle population it is doubtful whether any large number of the right class could be brought together at an early date for export. Three hundred head would probably be our limit for the first year, with a possible building up of the number of exportable beasts to 2,000 per annum in a few years.

*Market.*—Although the United States of America is the greatest beef cattle producing country in the world there was a decline in the number of beef cattle to the extent of 10,700,000 or 24 per cent. of the total between 1921 and 1927. The vast population of meat eaters in that country (123 millions) is causing a great drain on the beef cattle population and as a result 70 per cent. of the cattle slaughtered are hand-fed and forced for early maturity. This, of course, adds to the cost of production. It is unlikely that production will ever catch up to consumption and it is estimated that the United States will require more and more imported beef.

Hawaii is a part of United States territory and the same remarks apply. It is to Hawaii rather than to the mainland that the anticipated meat export would be made.

Except as ships' stores no other outside market for Fiji meat can be foreseen.

The re-opening of the meat-canning industry might lead to the exploitation of the other Pacific Island groups as a market for canned beef. The purchasing power of these groups, however, is dependent on a good price being obtained for copra. Until that improves there is practically no export for canned beef.

*Slaughter-houses.*—Properly equipped slaughter-houses are required according to the specifications set out in the proposed Meat Export Regulations. As far as Fiji is concerned very little is needed in the way of improvements to make the existing slaughter-houses comply, but nevertheless some improvements are necessary.

*Cold storage.*—Where cold storage is not available at the slaughtering premises it is essential that it be available at a reasonably accessible distance. This is the state of affairs existing here. Some cold storage space is available at the premises of two local butcheries and it can be considered as reasonably accessible.

The essentials required of these refrigerators are that they have sufficient capacity and are capable of reducing the temperature of quarters of carcases to at least 16 degrees F. in not longer than 24 hours. Meat must be frozen rapidly, that is, within the above mentioned time. There is then little, if any, bursting of muscle fibres or change in structure. Freezing should not commence until the body heat has left the carcase. Precooling therefore must be provided for. This is done by exposing the carcase, for from twelve to twenty-four hours after slaughter and dressing, to a current of pure cold air.

It has been assumed that the method of refrigeration would be the frozen meat system, mainly because our neighbours, New Zealand and Australia, adopt that system and ships are equipped for it. Since, however, Hawaii is only a fortnight away it would be possible to send chilled meat to that country. Under this system the meat is kept at a temperature of from 28 degrees F. to 30 degrees F. This is just below the freezing point of water. The meat arrives at its destination soft and is ready for immediate consumption. Chilled meat is preferred to frozen meat by the public. It cannot, however, be kept for longer than five to six weeks. If it can be arranged with shipping companies that method would be found more economical in refrigeration and more profitable in returns.

*Land transport.*—The distances and time occupied in land transport are short, therefore no elaborate vehicles are necessary. They must, however, comply with the standard of sanitation required by an Inspector under the proposed regulations.

*Sea transport.*—The export of meat is impossible unless shipping companies are prepared to supply cold storage space. Difficulty might be experienced in arranging this. It is unlikely that the ships' people would be prepared to open their cold storage holds to receive a few carcases only. If sufficiently large shipments can be got together at one time to fill a compartment it is more likely to be well received as cargo, and incidentally should attract more attention when offered for sale at its destination.

The shipping companies must carry the meat in a satisfactory manner as regards stowage, maintenance of an even temperature and general cleanliness. As, however, they are used to the trade and equipped for it, it is not anticipated that there would be any undue risk of loss or damage whilst in transit by sea.

The transport of carcases from cold storage to ships' side and actual loading should be well planned so that the whole process is done without delay. This is necessary to prevent serious rise in temperature of the carcases.

*Regulations.*—It is obvious that certain standards must be adopted to control the industry but more particularly so in the production of such a perishable article as meat. To do this, in the case of meat intended for export, " Meat Export Regulations " are adopted. Countries which buy the meat demand regulations substantially the same as those in force in their own meat industry.

Regulations ensure protection to the producer, the country of origin as a whole and to the consumer. The producer is protected from fraud by the elimination of argument which might possibly arise as to whether a certain carcase was fit or not for consumption and thus passed for consumption or destroyed. The country of origin has a reputation at stake and regulations ensure that all meat passed for export will be marketed to the satisfaction of the producer in the exporting country and to the consumer in the importing country. Certain standards must be conformed with in dressing the carcase and preparing it for export. It must be sound, wholesome and free from disease. The carcase must be uniformly and neatly dressed and not be mutilated in any way. It must be of good shape, colour and be firm. There must be no deterioration between the time of inspection at the slaughterhouse and delivery to the consumer. Re-inspection at the shipping port is provided for. A carcase, passed for export by the Inspector at the slaughterhouse may be withdrawn from export on re-inspection at any time before shipment, should it show deterioration. In brief, if the meat offered for export does not meet the approval of the consumer there will be no export.

As far as the consumer is concerned goodness or badness may be obvious or concealed. The part of the regulations which protect the country of origin will ensure that the meat is outwardly good. Without the backing of regulations, however, there is no guarantee to the consumer that the meat is free from harmful properties in spite of good appearance. The Certificate of the Inspector of Meat under the export regulations, therefore, becomes the hall-mark.

*The Meat Inspector.*—All countries of any importance require that imported meat shall be accompanied by a certificate of ante- and post-mortem meat inspection by a qualified veterinarian. The duties and powers of the Inspector are very wide. From the yarding of the cattle to the stowage of the carcases in the hold of the ship the process is under the supervision of the Inspector. The live animal must pass ante-mortem inspection in regard to disease, condition and quality. This inspection is continued to post-mortem and the whole handling of the carcase must be according to the requirements of the Inspector acting under the regulations. Refrigeration, transport and shipping are also under his observation, and, in addition, the carcase is subject to re-inspection at any time and must be so re-inspected before shipment.

It is essential that there must be available at least one qualified Government veterinarian at Suva for this work.

It will be seen that of the factors for a meat export trade discussed in this paper some are variable according to the energies of local producers whilst others are more or less fixed but subject to variation by advancement of scientific knowledge of general application. Among the variable factors are quality, supply and market. Having established a market, development will depend on improvement in quality and supply. Following that, my opinion is that if we have the goods the market will absorb them. The fixed factors are slaughter house control and construction, refrigeration and transport.

Conference adjourned until 9.30 a.m. on Wednesday, 14th October, 1931.

*Wednesday, 14th October,* 1931.

*Mr. E. Duncan* in rising to open the discussion on Mr. Turbet's paper, " The Stock Industry with reference to the Export of Beef," said that export production at world's prices must be the basis of the development of Fiji. He remarked that development for local consumption would never be successful, as it merely took money from one pocket and put it in another in the Colony and was restricted by the increase of the population of the Colony —a method of development much too slow ever to bring about the cultivation of the spare lands of Fiji or any worthwhile proportion of them within our lifetime. The primary producers of Fiji should be placed in the position to compete in the world's markets and that could only be brought about by reducing our costs of production in every possible direction. Another question bound up with the establishment of the meat export business was the conveyance of livestock at low rates of freight from outside islands to Suva. At the moment there was only one vessel in the Group capable of carrying cattle across the Koro Sea, nam ely, the subsidised steamer " Malake," and cattle freights by that vessel were practically prohibitive. He mentioned that a fat pig which would kill 200 ℔ dressed weight cost 4s. in freight from Taveuni to Suva, whilst a fat bullock which would kill 400 ℔ dressed weight or less cost 30s. for freight charges. Mr. Duncan said that not many years ago Taveuni supplied the major part of Suva's cattle requirements. The nucleus of the herds still existed on Taveuni and other islands, and production could be rapidly recovered—even exceeded—given facilities of cheap and proper transport to Suva or factory. He considered that such a factory under joint Government and producers' control would be successful if the necessary support were given by Government. Mr. Duncan thought that the Colony generally would be much better served by the development of an industry so old and successfully tried out in almost all parts of the Colony, and for which such large tracts of land in the wet and moderately wet districts of the Colony were so eminently suitable, and which was really a non-tropical or white man's sphere of production and income at present than by embarking on new and extremely doubtful and strictly circumscribed industries such as the people were constantly hearing about. Mr. Duncan hoped that the papers and discussions on cattle raising and beef production would lead to early, real and profitable results to the cattle grower partciularly, and also the Colony generally. It was his opinion that if earnestly, systematically, scientifically and promptly followed up, and having assured markets for all its products, the cattle industry would soon—after sugar and coconuts—be the biggest industry in the Colony and a solid and prosperous contributor to its development and finance, provided always that the Government was reasonably helpful. In conclusion Mr. Duncan said that he would like to empahsise that cattle were a necessary supplement to a well-managed copra estate. They saved much hand weeding and brought in a certain amount of income through sale to Fijians and always provided good beef for estate use. In fact, they were a sort of by-product on a coconut estate, and for that reason alone could be produced profitably in competition with any purely cattle-raising venture.

*Mr. Bayly* remarked that the opening speaker, Mr. Turbet, had said that there was one shipper who had endeavoured to ship meat to Honolulu without ascertaining the requirements of the American Government in regard to the importation of beef into that country. He said that the Company he was interested in had been endeavouring for the last two years, with the co-operation of the American Consul to ascertain the requirements of the U.S.A. Government He also referred to Mr. Turbet's remarks about the bulkiness of the regulations and said that he had suggested to the Government that this should not necessarily delay the framing of the regulations and that the real work fell on the person desiring to export the beef. Two years had gone by before Government announced that the proposed regulations were being drafted. He quoted from a letter from a Firm in Honolulu to the effect that it would be very difficult at the present day to work up a trade with Honolulu as the Army and Navy had decreed that all beef and, in fact, all commodities required were to be of domestic manufacture, that is, the product of the U.S.A., and he doubted very much if it would be possible to open a market in the U.S.A. territory. Mr. Bayly said that in the opening address it was stated that breeding was more or less subsidiary to feeding. He thought that it was recognised by all people interested in the production of cattle that feeding was an important matter, but the question of breeding could not be overlooked. He said that for the past ten years the men who had imported good strains of breeding cattle could be counted on the fingers of one hand, and that before we could hope to compete in the world's markets we must improve our cattle. With regard to the marketing of baby beef he informed the Conference that his Company had marketed cattle sometimes a little over three years old and they weighed 600 pounds dressed weight. This was done in face of the difficulties of bad roads and transport facilities which may reduce the weight of a beast by 50 to 100 pounds by the time it reached the slaughter-house. He considered that the stock industry was looked upon as the Cinderella industry of the Colony and whenever he wanted a piece of land it was given to him with a certain amount of unwillingness. He again referred to Mr. Turbet's paper in connection with the statement that the best stock was raised on river-flats. He informed the Conference that this cost a great deal more than hill-land and that his Company for one could not afford to have cows and calves on such land. He did not think for one moment that any man thinking of going into the cattle industry could breed stock on rich river-flats. He then touched upon the question of fencing. In Australia the agriculturists had to look after their fences, but in Fiji the man who was engaged in the raising of cattle had to do the work in connection with fencing his stock. He said that there were no recognised stock routes in the Colony and whenever drovers of cattle had to camp for the night they had sometimes to pay for the water from passing streams. He remarked that he had seen natives who knew that cattle would be driven along a certain road plant up an area of about four chains by half a chain wide hoping always that cattle would pass that way and they would be able to claim damages for their crops. Another difficulty was the tenure of land. At the present time there was a 99 years' agricultural lease, but pastoral leases were for 21 years with an option of renewal for another 21 years. Looking to the future development of the Colony we were forced to the conclusion that if there was to be real development in the stock industry the land tenure would have to be altered. He said that there were thousands and thousands of areas of land in the Colony which were suitable for pastoral pursuits. Two points had been brought before the Conference; one was that Fiji could produce beef of an excellent quality and the other was that we lacked the market in which to sell that beef. He remarked that there was no doubt that at the present time we had not enough beef for export and too much for local consumption, and that before we could enter the world's market we must be in a position not only to produce beef of good quality but also to have continuity of supply. In other beef-raising countries such as the Argentine, South Africa and Queensland there were large tracts of country where the wildest of cattle could be handled with ease by trained men on horses and no fencing was required beyond a few mustering paddocks and sheds at the central station. Every now and then a muster was held and the stock-owners obeyed the unwritten law that unbranded bullocks belonged to the man who had his brand on the mother with which the calves were running. In this way one could produce beef with a minimum of cost, but in Fiji we found that there were innumerable gulleys in the hills and that in an area of 50,000 acres there would not be one single flat area of 50 acres. Cattle which got into these gulleys were very difficult to get out and even sending dogs in after them was useless. The cattle which had wandered into these gulleys generally had to be shot. It meant that fences had to be erected and these fences had to be kept in repair which was a very costly process and required a large outlay of capital and also incidental expense. Another difficulty confronting the stock raisers in Fiji was the lack of suitable grasses. Turning back to the question of land tenure, Mr. Bayly said that his Company had a 21 years lease of certain land and 11 years of that time had expired. He considered that his Company was just on the threshold of the meat industry and that it was necessary to think about an extension. He was endeavouring to improve his cattle by the importation of pure stock and even with set-backs there was always the chance of improvement but it took time. In another ten years he might find himself faced with the expiration of his lease, in which case there would be nothing left for him to do but to slaughter his herd for the value of the hides and tallow. Mr. Bayly went on to say that the question of markets was the most important one that affected the stock industry to-day and he stated without commitment that the Company he was interested in was prepared to erect a cannery for a capacity of 3,000 head per annum provided that they got the assistance from the Government relative to long tenure and also a protective tariff system in the market. He said that he made this statement in all seriousness. In concluding Mr. Bayly referred to the excessive amount of cattle stealing which went on in the Colony. Every assize at Lautoka there was one or more cases of cattle and horse stealing and he thought that this could be accounted for by the fact that the Branding Ordinance was not enforced. Most of the cases of cattle stealing were Indians, but in some cases Europeans had been guilty. He said that the cattle of Fiji ran into tens of thousands and he was quite sure that less than 100 carried their registered brand. He remarked that for a good many years the ear-mark had been recognised as the mode of ownership, but he considered that the ear-mark was only useful for different ages of cattle and for identification the cattle raisers were deepndent on the fire-brand. He said that he had endeavoured to place before the Conference some of the trials and troubles which faced the stock-raising industry and he would advise any person who was thinking of going into the cattle-raising business to be sure and look after his fences and not to let his cattle get out of control. If he did this he might as well write them off as valueless.

*His Excellency* said that he had been very interested in the remarks of Mr. Bayly and that the points raised by him would be carefully considered. He assured Mr. Bayly that Government would assist in every possible way. He remarked that he had lately returned from a tour of the Western Pacific and had ascertained that a large quantity of beef was consumed in those Islands. He said that some effort would be made to give a British preference tariff in these Islands which might perhaps assist Fiji in disposing of the surplus meat produced in the Colony. With regard to the question of leases His Excellency remarked that he would investigate this matter.

*Mr. Barnes* said that the question of the export of beef was not a matter that could be dealt with quickly and he fully sympathized with Mr. Bayly. Voluminous correspondence had been constantly passing in connection with this matter and he could assure the Conference that inquiries had been conducted with the utmost despatch since the matter was first raised in 1929. Various attempts had been made to alter the local regulations in order to meet the requirements of the principal meat importing countries of the world. In this connection the Department of Agriculture had in mind not only the territory of the U.S.A. but also countries of the British Empire which might, were shipping facilities available, be able to take a portion of our output. Copies of the Australian Meat Export Regulations had been obtained and adapted to local requirements. He had the permission of the Governor to submit these draft regulations to the Conference before they were approved by Government. He could assure Mr. Bayly by direction of His Excellency the Governor that the matters that had been discussed would receive every consideration.

*Mr. Turbet* said that he would support Mr. Duncan's suggestion to form a Meat Industry Board to be established to foster the meat industry of the Colony and devise means whereby this important phase of the Colony's activities might be improved, something on the same lines as the New South Wales Metropolitan Meat Industry Board. This Board had their own slaughter-yards and refrigerators and the whole of the meat business of the metropolitan area of New South Wales was handled by the Board. He said that the cost of this large establishment was borne practically by the profits of by-products; there was no waste in the slaughter of beasts. In connection with Mr. Bayly's reference to the statement that export cattle should be produced on river-flats he said the idea was to bring export cattle to as early maturity as possible and not to prejudice the production of range-country cattle. He remarked that even among the range-country cattle the best could be used for export and the others for local consumption. With regard to stock routes, he considered that if the Meat Industry Board were appointed this was a question that could be considered by them and there was no reason why stock routes should not be immediately proclaimed. It would be necessary for owners of plantations on stock routes to fence them. He said that he would emphasise the fact that the development of the industry depended on a market in addition to the local market and perhaps the canning of meat would be a solution. The Colony might be able to do more in this connection on account of the greater ease with which the product could be carried than carcases. Referring to the question of branding he considered that the ear-mark was useless as a means of identification of stock. The ear-mark was liable to mutilation, liable to be absolutely cut off. About 80 per cent. of the cattle owners of Fiji used the same ear-mark.

*Mr. Bayly* said that before the discussion terminated he would like to add a few remarks about the ear-marking of cattle. He considered that the solution of the problem was for the Government to make it necessary for a person to have a proper ear-marking machine. At present the trouble appeared to be through the ear-mark being made with a knife.

*Mr. Duncan* moved the following resolution:—

> That a body should be appointed by the Government to investigate fully the cattle industry of the Colony with a view to examining its present condition of over-production and future possible expansion relative to the establishment of a profitabe export trade associated with similar utilization of other animal and vegetable products.

Seconded by Major Willoughby Tottenham.

Resolution carried.

*Mr. Surridge* read his paper " The Production and Marketing of Supplementary Crops " as follows:—

Fiji in the past has been accustomed to think only in terms of sugar and copra. More recently bananas attained importance until the embargo was placed on them by Australia. More recently still the dairying and pineapple industries have come into being and are now passing through the difficulties that beset the establishment of new industries. There is, however, one factor which is common to these branches of agriculture and that is that each has " all its eggs in one basket " so that when depression comes there is a hurried look around for other sources of income. Probably the greatest risk incurred in agriculture is that of specialising in one particular branch and to avoid this the question of supplementary crops requires consideration.

Agriculture is probably the most uncertain of all industries owing to the fact that the prime factor on which it depends is largely, at present, beyond the control of man. I refer to the weather. In colder climates this handicap has been tackled with energy in certain branches of the industry, mainly in that of horticulture, with remarkable results.

We have not the same handicap as regards temperature, but our difficulties are climatic, which while favourable to the production of many crops in season and out of season as far as our immediate markets are concerned, handicaps the producer by sapping his energy and initiative to an extent not generally appreciated. It is this latter factor that operates severely in the production and marketing of supplementary crops, for these crops demand of the producer a higher order of energy and initiative than is the case with many of the so-called major crops. Major crops generally may be classed as those required for man's necessity, while many of the supplementary crops may be classified as luxuries, and for successful treatment demand of the farmer the same intensity of treatment that is accorded them in colder climates, for many of these crops are only in demand through man's business acumen, industry and propaganda. Further, where those supplementary crops have received earnest attention, the returns per acre from such crops are often phenomenal. It is not unusual for gross returns to reach £200 per acre, and under certain systems of market-gardening, the gross returns are considerably higher. To achieve this three things are essential—(1) personal organising ability, (2) the ability for real hard work, and (3) the production of crops *out of season.*

The first two essentials are qualifications necessary for all successful enterprises and none more so than when intensive agriculture forms the outlet for such abilities. The third is the basis on which the first two can achieve success.

Fiji is so situated that the climate enables us to produce certain of these supplementary crops " out of season " for the markets that are nearest and of greatest interest to us, viz., New Zealand ,Australia and Canada. I will instance one or two cases from England, illustrating the advantage of being able to produce certain crops out of season:—(1) Tomatoes there realise 3s. to 4s. per lb when put on the market one to two months ahead of the normal season, when this fruit is retailed at 4d. to 6d. per lb; (2) strawberries produced during winter have realised £1 per lb avoidupois; the normal season price would be from 4d. to 8d. per lb; (3) grapes during the winter and early spring will fetch 10s. to 15s. per lb; during the season they have been retailed at 1s. per lb; (4) pineapples from an English hothouse will fetch 10s. to 15s. per fruit. Imported fruit has been retailed as low as 6d. each.

These differences emphasise the value of supplying produce when it is out of its normal season, on various markets, and the extra cost involved is more than compensated by the higher price obtained. With these examples in mind and the fact that the climate here is generally favourable for the production of fruits and vegetables at those times when they are out of season elsewhere there would appear to be ample scope for us to concentrate more thoroughly and effectively on certain supplementary crops to our advantage. The crops that occur to me are tomatoes, cucumbers, melons, pumpkins, French beans, egg-fruit, kumalas, pineapples and bananas.

Before passing on to a discussion of the various crops there are certain factors concerning production that should be considered.

*Climate.*—I have already stated that we have the climate to produce certain crops at times of greatest scarcity in other countries, but it is necessary to differentiate between these crops. Some of them are tropical, some sub-tropical, while others are on the border line of sub-tropical and temperate climate crops. For this reason discretion is necessary in the methods and locations adapted for the production of the crops in question. Tomatoes, for example, do not give maximum yields at temperatures exceeding 80 degrees F., the optimum lying between 60 degrees and 75 degrees. Again, while requiring the maximum of sunlight in a temperate zone, tropical sunlight is probably too strong and therefore detrimental. Much work requires to be done to discover the optimum conditions for those introduced crops which we, by long association in more temperate climes, assume should do just as well here.

*Tools.*—If we examine the tools in general use on a plantation it will be noted that progress has been made with reference to horse or tractor implements, but hand implements remain the same as when indentured labour was first introduced. The cane knife is a very light and useful tool, but the square hoe is a very heavy and cumbersome implement and one which, in my opinion requires the maximum of effort while achieving the minimum result.

The object of hoeing is to destroy the weeds and move the soil, thereby producing a fine tilth and mulch one inch to two inches in depth. To secure this desired result a horse hoe should first be worked between the lines and then followed with a light hoe, for example, the swan-necked draw hoe type which properly used will achieve the object of hoeing to greater advantage in that it is easier and lighter to manipulate and therefore not so hard on the labour, enable the work to be done more efficiently and more expeditiously, and allows of a closer working around the plants at all stages of their development. I have discussed the hoe at some length because it is perhaps the most important and useful implement in the successful production of supplementary crops.

Too much emphasis cannot be laid on the necessity of getting in amongst the crops with this implement as early as possible; that is, as soon as the plant is big enough to be distinctly seen, or in the case of transplanted ones, as soon as it is observed that the plants have taken hold and are becoming established. Attention to this detail ensures stronger and healthier plants with a resultant increase in returns.

*Sowing.*—This is controlled by market requirements and the object is not only to sow for the earliest market but to sow in succession to ensure a regular supply right through the season. Apart from quality of produce nothing tends to stimulate and maintain a demand for that produce as the regular supply of a good standard article. The first sowing therefore will be made at a time sufficiently in advance to ensure that the plants will commence bearing when required. Sowings in succession about every three weeks will maintain the supply and avoid failure.

*Objects of production.*—Obviously when producing a crop it is essential to know the purpose for which it is required. With those crops under discussion the main purpose is for human consumption, as fresh fruit or vegetables, but other objects should be considered. It is expected that our nearest markets will continue to absorb the produce we supply, but we have had one experience of a market being deliberately closed to our produce and such might occur again. Hence the necessity for preparing for such an event and thus making the production of supplementary crops a permanent industry. England is pointing out to us methods to be pursued, for having suffered year after year with gluts of fruits of various kinds, and also importing huge quantities of such produce, the question of food preservation by canning, &c., is now being tackled with remarkable success. In our case, the question of the disposal of our produce by canning, sundrying or for juice extraction should be seriously considered for it would enable our produce to be sent wherever there is a market, at all times of the year, thus extending our sphere of influence and increasing our prosperity. This is being done with pineapples and can be done with other crops. Further, we have already a small trade in seeds, I refer principally to Mauritius Bean, but it is possible and the matter is now being investigated, that certain other crops may be grown not only for the table but for seed purposes also. In this way waste would be eliminated and the producer would have an extended market and a more uniform return for his labour.

*Rotations.*—One of the greatest difficulties met with in intensive cultivation is the continuous supply of manures other than artificial manures. With the increase of motor traction, stable manure is almost unobtainable in some countries, and here in the tropics what little is obtainable is rapidly exhausted in the soil owing to the high soil temperature which facilitates decomposition. There is, however, a method by which this lack of suitable manure may be largely obviated, that is by the practice known as "crop rotation."

The food requirements of each crop vary, as also do the root habits of those crops; some travel deeply, others are surface rooting, while some again leave the land richer and in a more friable condition, as is the case with most leguminous crops. If the same crop is grown continously on the same land it is obvious that pests will have a continuous supply of food, and control of pests and diseases will be rendered more difficult.

In working out a system of crop rotation those facts should be borne in mind and the utmost use made of any leguminous crops grown either for export or for their green manurial value as a means of supplying plant food deficiencies, humus to the soil and changing the crops to be grown. Plants of the same natural order should not be grown in the same soil since they usually offer themselves as alternative hosts to the pests and diseases of the previous crop. By careful rotation, then, the soil is not so readily exhausted and pests and diseases are not given the same opportunity to produce themselves at the grower's expense. The longer the rotation, that is the greater the interval of time that elapses before a crop occupies the same land a second time, the greater the benefit to that crop whether for food supply or from the point of view of plant sanitation.

It does not come within the scope of this paper to discuss pigs and poultry, but I suggest these animals for inclusion in a crop rotation. Experience in England, America and elsewhere has demonstrated that this is both practical and valuable. Both animals are bad gardeners when allowed to roam amongst crops but if suitable pens are made that are strong and portable and high enough to contain either the pigs and/or poultry they can be moved on to the land as soon as a crop is finished, to clean up the residue of that crop, destroy the weeds and insect pests, and add valuable manure to that land, as well as giving meat and eggs in exchange for the waste materials supplied.

*Crops.*—The following are brief cultural details of the crops under consideration, together with a produce list that will indicate the export season for the various crops.

*Tomatoes* (*Lycopersicum esculentum*).—Require a good rich well drained loam. Seed should be sown in light rich soil some 3—4 months ahead of when required to fruit. I would suggest that all seed beds be thoroughly watered with a solution of the Cheshunt compound, as a preventative to the "damping off" and other soil fungi that attack the young plants. Transplanting should be done when the seedlings are 4-in. to 6-in. high and at the time of transplanting each planting hole should receive at least one pint of the above solution, the same amount being given after the transplanting. The Cheshunt compound is not a panacea for all soil ills of the tomato but it is of great assistance in the prevention of soil fungous disease and usually repays for application by avoiding the necessity for replanting. Further, the solution stimulates the young plant and tends to prevent the check occasioned by transplanting. When the seedlings have become established they should be carefully hoed and should receive frequent hoeings as long as it is possible to work amongs the plants. When the plants are in flower pollenation may be assisted by lightly shaking or jarring the plants, usually at mid-day. Plants may be set at distances varying from 18-inches to 36-inches depending on soil, variety and method of staking, for plants usually do better staked than trailing as a vine. Water should be given as required to maintain steady growth until the blossom buds appear. During flowering the plants should be kept on the dry side until the first truss has set when liquid manure should be supplied with or without a surface mulching of decayed manure, leaves, &c. As growth proceeds all side shoots should be pinched out until the fourth truss has set when a strong leader, the second shoot below the point of stopping, should be allowed to start out to continue the crop.

A good artificial manure to be applied when preparing the land is:—

Superphosphate 5 cwt per acre.
Sulphate of Potash 2 cwt. per acre.
Sulphate of Iron ½ cwt. per acre.

When fruiting, some advise applying nitrate of soda or sulphate of ammonia at the rate of 2 cwt per acre, but others maintain that a nitrogenous manure depresses the yield., It is recognised that the tomato responds to potash and phosphates, but nitrogen should be applied with discretion.

*Disease.*—Those diseases met with here are usually soil fungi which, in the present state of our knowledge are beyond definite methods of control.

Soil sterilisation on a large scale is not a practical proposition in Fiji; therefore the best means of defence is to use as far as possible resistant varieties, *e.g.*, Marglobe, Norton, to destroy infected material by burning and to rotate the crops as already suggested. Attention to plant hygiene and more knowledge as to methods or locations for cultivating this crop offer fields of investigation which will be dealt with as early as possible at the Government Experimental Farm.

Cutworms are often a serious pest to young plants. The method of control is the use of arsenical sprays or arsenical baits. The better way would be, in my opinion, to introduce poultry into the rotation.

*Cucumbers* (*Cucumis sativus*).—This crop will stand a rather higher temperature than tomatoes provided plenty of moisture is available. The soil required consists of two parts good rich loam to one of well rotted manure with a liberal admixture of sand to keep the whole open and porous. If a compost of this mixture is made up, then planting holes 18-inches diameter and 12-inches deep may be dug and filled with the mixture ready for the seed when planting out. The large amount of humus in this compost will keep the soil moist.

Liquid manure should be given freely when the plants have reached the limit of space allowed them, and while fruiting. Each fruiting stem should be pinched at the second leaf beyond the fruit; continuous and judicious stopping is necessary throughout growth. When practicable, pollination should be carried out since this ensures a more certain crop and is easily done, both male and female flowers being on the same plant.

The three essential points with cucumbers are:—

1. a rich friable compost;
2. frequent applications of liquid manure and water;
3. continuous and judicious stopping throughout growth, and finally, one that needs investigation, protection from excessive light.

*Melons* (*Cucumis melo*).—Require a firmer soil than cucumbers, more light, and less water, and therefore a drier atmosphere.

The best soil is that obtained from well rotted turves from grass land; this mixed in the proportion of 2 of soil to 1 of well decayed manure plus basic slag (2 ℔) superphosphate (1 ℔) to each load of the compost forms a suitable mixture. Cow dung is excellent for the purpose.

Sowing should be 2 to 3 months prior to fruiting the plants being 1-foot to 2-feet apart, and when from 15-inches and over in length should be top dressed with the compost and the points pinched out to encourage fruiting. The laterals should be treated in the same way by pinching at not less than 1 joint above the fruit; this will avoid overcrowding. When watering, the stems must be kept dry, otherwise they are liable to rot. As with cucumbers pollination should be carried out. It is recommended that plants be restricted from 5 to 8 fruits according to the vigour of the plant and size of fruit desired. Judicious watering with liquid manure during fruiting will add to the size and quality of the crop.

*Pumpkins* (*Cucurbita maxima*).—Soil requirements are similar to those of the cucumber and melon in that a good rich soil is required. Seeds may be sown in holes previously prepared in a way similar to that required by the cucumber, some three months or so before the fruit is required, the vines being allowed to run over the ground without supports. Liberal waterings either of water or liquid manure should be given as required.

*French beans* (*Phaseolus vulgaris*).—This is a crop that has not received the attention which it appears to deserve, for export purposes. There is a limited market in Auckland from May to October, capable of absorbing according to present information about 1 ton of these beans a month One consignment of French Dwarf and Canadian Wonder—some 35 ℔ in weight—was despatched recently to New Zealand where they realised 9½d. per ℔, equivalent to 4·3d. per ℔ on the wharf at Suva As this shipment occurred near the end of the season it is reasonable to suppose that prices should be more advantageous earlier in the year. Even so the return is higher than is obtained in the local market.

Deeply worked soil is essential together with a dressing of lime (1 ton) or coral sand (5 tons) superphosphate (4 cwt.) and sulphate of potash (1 cwt.) per acre. If compost or well rotted manure is available it should be sown in the furrow over which the beans will be planted.

Seed should be sown in treble rows, at about 9-inches apart in rows that are 2-feet apart centre to centre. Sow at intervals of three weeks throughout the season. When the flowers have set and the pods are forming applications of water and liquid manure would be beneficial to ensure rapid and succulent growth as beans for overseas must be tender to secure a fair price.

It is possible, however, that a certain proportion of the crop will be too old for shipment, or local prices too low to give a satisfactory return. This difficulty is at present being investigated along the following lines. At the Government Experimental Farm at Navuso a proportion of the crop was allowed to run on for seed. Samples of this seed are being despatched to Auckland and Sydney for examination and report, and if its germination and bearing qualities have not been impaired by production in the tropics and if reasonable prices are offered for sound clean seed of certified germination and purity, the growing of French beans for export, both for table and seed purposes, should be profitable.

*Egg Fruit or Bringals* (*Solanum melongana*).—Cultivation is very similar to that of the tomato. Seed should be sown in boxes containing light rich soil and the seedlings transplanted when about 3-inches high into rows 3-feet by 2-feet. The hoe should be used freely as in the case of the tomato to maintain a good soil mulch. If possible a mulching of rotted manure and leaves should be given. Plants yield an average of 12 marketable fruits a season.

Varieties:—The purple is favoured in our markets, but the white might be worth while trying although stated to be of not such good flavour.

*Kumalas* (*Ipomœa Batatas*).—The sweet potato is familiar to us all and forms a useful export crop apart from that required for local consumption. A good moderate friable soil is required which should be well and deeply cultivated, and ridged, the ridges being about 2½-feet apart. Cuttings should be planted in the ridges at about 12-inches to 18-inches apart. Better results are obtained from cuttings than from tubers and it is a good plan to plant tubers in nursery beds and then cut off the stems when a foot long and plant these. Planting should be done for preference during rainy weather, and when the plants have rooted they should be hoed, care being taken not to damage the foliage. At the second weeding a final earthing up should be given. The crop matures in about 4 months and returns about 4 tons to the acre. Crop rotation should be practised. This crop greatly benefits the land by the continuous cultivation given up to and during the harvest. The leaves are excellent fodder.

Varieties:—The white preferred in the Canadian market. The red and pink preferred in the New Zealand market.

*Pineapples* (*Ananas sativus*).—At present we are concentrating on the canning pine—the smooth leaf Cayenne and no attention is paid to producing a good quality dessert pine either for local or export trade. The " Ripley " pine is probably the best, being very sweet and a good traveller, but stocks have deteriorated and the matter is receiving attention by the Department both as to stocks, quality of fruit and methods of marketing, to discover the possibilities of this branch of the trade. If Queensland can export pineapples at a profit to New Zealand, there is no reason why we should not do at least as well. We should do better.

*Bananas* (*Musa sapientum*).—This crop is receiving considerable attention at present but the methods of packing, transport and marketing of this soft fruit need careful investigation so that our market may be extended beyond New Zealand.

There are other crops that will occur to you, but in all cases the fundamental principle behind successful crop production is care and attention at all stages from the sowing of a crop until it has been placed on the market.

*Marketing.*—If crop production is a science the marketing of the crop is not less a science, demanding just as much energy and concentration of effort to secure a successful result. The producer should so handle his crop that by putting good quality produce on the market in as attractive a manner as possible the consumer will be induced to buy at all times.

*Handling of Produce.*—With all perishable produce the greatest care is necessary and should be enforced at all stages between the plantation and the steamer at Suva.

Bananas are rough handled from the time they are cut off the tree until they are packed into the case and sometimes after. Unfortunately much of the damage is not apparent until after the fruit has left Fiji. In view of the increasing competition from Samoa and Cook Islands, it becomes increasingly important that the utmost care should be exercised. The difficulty is that of educating those people immediately concerned.

With tomatoes the fruit should be gathered and either automatically graded and packed directly into the case or else taken to a cool packing shed on the plantation to be packed for markets. The present system which involves collection from the plant into any available receptacle, carting to a central packing station, when the fruit is dumped on the floor in heaps 2-feet or more deep and perhaps left overnight before being packed does not tend to improve such a soft fruit. The present method of grading involves selection from the heap so that the fruit is handled many times to secure the correct sizes. It is hoped shortly to improve the system.

One can appreciate the amount of bruising possible under such conditions. After packing, the fruit is carried in lorries to Suva, the vibration by no means improving it; the voyage from Suva to the markets occupies several days.

Such a system is wasteful of time, fruit and energy. It is typical of the treatment accorded to most produce exported from Fiji and represents how *not* to do things. I would repeat that to ensure produce travelling well and arriving in sound condition on the market, the greatest care and attention should be given at all times.

*Packing.*—All are familiar with the attractive packages in which various commodities are received from overseas for sale in this Colony, and without exception both the sales and prices obtained represent a reasonable profit to the producer or manufacturer. These attractive packages are the result of sound business acumen and keen competition. The most familiar goods with us are the Australian fruits in cases or cans, Californian fruits in cartons, cans, &c., and confectionery. In each case the producer and manufacturer has realised that he has something worth selling and has induced the consumer to appreciate the fact by the type of package in which the goods are marketed. Contrast this with the cases which leave Fiji fillied with bananas, oranges, tomatoes. If the timber for these cases was dressed a marked improvement in appearance would immediately be observed with negligible additional cost. Where paper wrapping is allowed, further improvement in appearance can be effected by lining the box or wrapping the fruit in white or coloured paper.

Finally, an important point in packing is overlooked in this Colony. Certain classes of produce allow for definite methods of packing and since in many cases the first or bottom layer in the pack is more uniform and attractive that the last, the mark or brand should be placed upside down so that when the case is filled the lid will automatically be made the bottom of the case. In this way the mark indicates " right side up " and the best layer receive due prominence.

*Grading.*—Having secured improvements in handling of the produce and the containers used, the next step is to grade the produce. Many consider grading unnecessary, but it will be found that the keener the competition the greater the necessity for grading in order to market a standard product. A case of fruit of good quality, well graded and packed and marked accordingly will always command and maintain a higher price even in times of glut.

The merchants in Fiji who import apples, &c., buy those apples on the brand, never seeing the fruit until after arrival in the Colony. Such brands by careful attention to the points already enumerated in this paper have obtained such a reputation for quality, &c., that confidence is inspired in customers hundreds of miles away.

In many branches of agriculture and industry grading has been introduced by legislation owing to the stress of competition, with the result that ungraded produce has no sale outside the local market.

*Standard or National Mark.*—Many successful business organisations can trace their success not only to the quality of goods produced but to the adoption of a " Trade Mark." To-day many countries have adopted a national mark as an indication not only of the country of origin but also as a recognised standard of quality. This adoption of a standard or national mark represents one of the best and cheapest advertisements for assisting good quality produce on the market.

Fiji is without such a mark at the present time, but that registered for use by the Department of Agriculture, viz., the Fijian's head over the word Fiji, is one that is distinctive and attractive, and through the efforts of the Department is becoming recognised as a standard of good quality produce. This mark should form the basis of a national mark for produce of recognised quality and packing exported from the country. I commend this to your serious consideration.

*Fruit Preserving and Fruit Juices.*—The preserving of fresh fruit by canning is already practised in Fiji with reference to the pineapple but I look forward to the time when our canneries will not restrict themselves to one crop but extend their operations to include tomatoes, fruit juices and other products. With our climate and soil many varieties of fruits and vegetables can be successfully grown but as this branch of agriculture extends, means to market surplus crops will have to be considered so that our export markets may be extended beyond New Zealand and Australia. Many fruits and vegetables can be canned or sundried or both, others are suitable for essential oils or juice extraction. Recently a proc ss has been invented and patented in England by which fruit and vegetable juices may be extracted and preserved indefinitely without the addition of harmful preservatives. The process, called the " Matzka treatment " involves the destruction of organisms producing fermentation, putrefaction and disease present or likely to be present in the freshly extracted juice. Such a process would tend still further to eliminate waste and extend the possible markets open to the producers.

*Co-operation.*—Co-operation has been preached in many places for many years with varying success. One of the first of the agricultural countries to adopt and extend the idea was Denmark, when some seventy years ago, the agricultural industry put its house in order and established the co-operative movement throughout the land. The result has been that the Danish producers are a very prosperous community and one of the most serious competitors that the Empire dairying industry has to face.

The fruit growers of California have, in more recent years, demonstrated the value of " getting together " by the way in which their fruits, &c., are spread in many markets. In Great Britain, several agricultural communities appreciating the benefits of " getting together " to purchase and to sell produce, have formed their co-operative societies with advantage to themselves.

In Fiji co-operation is familiar to the native, but not to the other residents in the Colony. During my peripatetic work I have discussed the advantages of co-operation amongst copra and other producers. Interest has been aroused only to subside apparently for the lack of will to pull together.

Co-operation is not a panacea for all marketing troubles, but a band of producers combined together can more successfully enforce the benefits of packing grading and marketing of produce than the individual. Machinery for grading and packing could be obtained by such a body and transport, canneries and shipping facilities improved.

Time does not permit of a full discussion of this point, but it is offered for the serious consideration of all concerned.

*Propaganda.*—Before concluding this paper, I would draw attention to the old axiom, " it pays to advertise." Some fifty years ago, the banana was considered a luxury fruit on the English market. It is now a popular fruit on which an enormous trade rests. This has been brought about by propaganda, in which the health and dietetic value has been broadcasted under such slogans as " Eat more bananas," " Bananas are recommended by the medical profession." The success of this and other industries has been largely due to suitable and vigorous propaganda carried out by the particular branches of industry concerned.

Fiji cannot afford to hang back, provided she has the quality goods to offer, and if co-operation amongst producers can be brought about, propaganda dealing with their various products should be conducted so that the produce is known outside of Fiji.

In conclusion I would suggest that co-operation grading, packing and efficient propaganda constitute very important essestials in the successful marketing of perishable and other produce.

Appended is a " Produce for Export " list indicating the seasons most profitable for export, and the markets concerned.

PRODUCE FOR EXPORT.

| *Crop.* | *Season.* | *Destination.* |
|---|---|---|
| Bananas | January–December | Auckland. |
| Beans—French | August–October | Auckland. |
| Mauritius | July–November | Sydney, Brisbane. |
| Bell Apple | June | Sydney. |
| Coconuts (whole) | January–December | Vancouver. |
| Cucumbers | May–October | Auckland. |
| Egg Fruit | June–December | Auckland |
| Ginger | March–October | Sydney, Vancouver, Auckland. |
| Grenadillas | January–December | Auckland. |
| Kumalas | June–November | Sydney, Vancouver<br>Auckland (August), |
| Mandarins | March–June | Auckland. |
| Melons | September–February | Sydney, Auckland. |
| Oranges | March–June | Auckland. |
| Papaya | September–December | Auckland. |
| Peanuts | March–June | San Francisco (March),<br>Auckland (June). |
| Pines | October–January | Auckland, Vancouver. |
| Pumpkins | September–February | Sydney. |
| Tomatoes | August–December | Sydney (August–October).<br>Auckland (October–December) |

*Major Joske* said that it was a great pleasure to listen to such a full and interesting paper as the one read by Mr. Surridge. He did not think that Mr. Surridge intended to convey the idea that any European could make a living out of pumpkins, tomatoes, &c. He suggested that the co-operation of the Chinese Consul, the Secretary for Indian Affairs and the Secretary for Native Affairs should be sought in connection with this subject as the large proportion of pumpkins, tomatoes, melons, &c., were exported by Chinese, Indians and Fijians, and it was to them that we had to look for the production of these crops in the future. He remarked that one of the leading Fijian Chiefs had said to him " Why don't we have a Fijian Agricultural Conference ? " Why also were not Indian and Chinese Agricultural Conferences held ? The Conference had heard a good deal about the future development of the banana industry in Fiji; in relation to supplementary crops we had products which were solely in the hands of Fijian, Indian and Chinese population so that again he expressed the need for the Department of Agriculture to extend their advice, their sympathy and their help to the Indian, Fijian and Chinese growers. He said that as far as bananas were concerned we should be able to meet the competition from Tonga and Samoa and if we could not then Fiji deserved to lose the trade. He said that Mr. Surridge had mentioned in his paper that £200 per acre per annum could be made from the cultivation of certain crops. He wished that it was possible to convince some of the present settlers in Australia and New Zealand of these figures. He knew of many thousands of acres of land which were available in Fiji at a nominal rental of £1 per acre per annum. Major Joske remarked that tomatoes were a very useful crop which was grown almost entirely by Chinese, and these had been bringing into the Colony something like 8s. or 9s. per case, which was a point well worth considering by our Asiatic population. The co-operation of the Chinese Consul should be sought in translating the very excellent cultural notes of Mr. Surridge's paper for circulation.

With regard to the question of grading, Major Joske intimated that if grading of bananas was undertaken then the system of purchase would have to be altered. At the present time bananas were bought by the case and it was possible that a loss would be sustained by grading the fruit in Suva. If the system were altered and purchases were made by weight, payment being made at so much per pound, this would get over the difficulty. In Fiji bananas were grown in very scattered districts and not in plantations as they are in Australia.

Touching on the question of co-operation he said that this was a very difficult thing even among Europeans of the Colony and he thought that it would be extremely difficult to devise a workable scheme amongst the Fijians, Indians and Chinese. As an example of co-operation he referred to the Coconut Planters' Union Limited which comprised members of the copra producers. This Union had been running for something like ten years; it was concerned solely with the collecting and shipping and selling of copra and had been successful for two reasons; firstly, because it had dispensed entirely with trading, and, secondly, that it had dispensed entirely with ordinary politics. These two factors he said had been the cause of the wreck of most Co-operative Societies in the Colony. In normal years the Union distributed amongst its members somewhere between £25,000 and £100,000.

With reference to propaganda he thought that this was an excellent thing and could be easily managed as far as the European producers were concerned, but with regard to Chinese, Indian and Fijian producers he considered that it would be very difficult to convince them of the advantage of advertising in Auckland and elsewhere. He remarked that on a recent visit to Auckland he had been accused of advertising over the air. He considered that there was a very definite necessity for advertising and he thought a small export levy might be made on the export of bananas for instance, the sum realised to be spent on the advertising of Fiji fruit in New Zealand. He would not suggest a small insert in the daily papers, but considered that the scheme should be put in the hands of an Advertising Agency and a day or so before the "Tofua" arrived in Auckland signs depicting Fiji and Fijian bananas should be shown in the picture theatres. He remarked that those who had visited the Agricultural Show would doubtless have seen the very fine posters which had been prepared advertising Fiji and he considered that there was excellent local talent available which should be utilised.

There was one other small point that he would like to direct the attention of Mr. Surridge to and that was kumalas. Mr. Surridge had shown the season for kumalas as from June to November, the Auckland season commencing in August. His experience had been that the season was now over for all practical purposes. The season had been a good one for kumala as far as Fiji was concerned because the local crop in New Zealand had been a failure and the cold weather had lasted longer in New Zealand than normally. The Maori was the principal consumer of kumalas, but they did not eat so many in the hot weather as they did in the cold. He informed the Conference that when the returns of the last shipment were received it would be found that the price had dropped considerably. In connection with the development of pure line seed, he remarked that Mauritius beans had been grown for many years in Fiji and should be encouraged, but unless something was being done to improve the seed he considered that the quality would deteriorate. He would like to see the Agricultural Department, if it was not already doing so, develop suitable strains of Mauritius beans which would be suitable for use in this Colony. Some results had been obtained with the growing of Sonacalif rice seed and although it was rather early to come to a definite conslusion in this respect there was every indication that this would improve the quality of rice produced in the Colony.

*The Chairman* suggested that the paper on the Pineapple Industry should be now read and discussed in connection with Mr. Surridge's paper.

*Mr. Barnes* read Mr. G. Garrick's paper "Pineapple Growing for Canning" as follows:—

*Selection of land.*—Pineapple growing in Fiji has been carried on sufficiently long to prove that certain theories, accepted and established in Hawaii, do not apply here where selection of land is concerned. Pineapples will grow and produce equally well at sea leavel as they will at 500 feet above sea level. Suitable land may be described as low undulating hills which can be worked by machinery. Steeper country is equally good, but expensive to work. Experiments being carried out on river flats are not yet complete and until completed it is suggested that such land be avoided for pineapple cultivation. Fruit produced on river flats may appear perfect, but if the soil contains too much moisture then, as likely as not, the core of the fruit will be found to be a brownish colour and such fruit will be rejected by the factory as being unfit for dcanning. Provided pine apples are cultivated on hill sides and drainage is good, a heavy rainfall is not an adverse factor.

*Nature of soil.*—The soil on the Island of Ovalau has been and is producing a pineapple which when canned has been pronounced by experts to be equal to if not actually superior to, the highest grade of canned pineapple for sale on the world's markets. The soil of Ovalau where extensive cultivation of pineapples is being carried on, is of reddish brown colour. When dry it is very loose and friable, and after rain drains itself very quickly. The iron content is good and in a form easily and readily absorbed by plant life; this feature is essential to successful cultivation of pineapples. The localities referred to are Wai-ni-Loka, Bureta, Waidau, and Viro. Experiments carried out on river flats at Waidau should be sufficiently finalised by December, 1932, to decide the suitability or otherwise of this class of land for pineapple cultivation.

*Drainage.*—Proved suitable land will drain itself, *i.e.*, hill land. It is sometimes necessary to instal a system of drains to prevent erosion. No hard and fast rule in this respect can be laid down and the particular nature of the country must decide the system to be adopted. The general principle is to select a natural valley or water-way and into this lead feeder drains cut so as to permit the water to flow slowly. The thing to be avoided is a sheet of water coming down a hill-side carrying tons of soil with it.

*Preparation of soil.*—Hill-sides with an angle of slope not exceeding 25 degrees may be ploughed. From 25 to 45 degrees should not be deeply cultivated owing to subsequent rapid erosion from heavy drains. The pineapple plant has a small root system, which does not need deep tilling as has been proved from experience. If the land is as described under the title of " nature of soil," then all the " cultivation " necessary can be done with a mattock, and a strong arm. Dig a hole some 8 inches in diameter and 5 inches in depth and loosen the soil so dug and replace in the cavity it was dug from. This method is cheap and will produce excellent results. It is time enough to use the plough when exhausted ratoons have to be ploughed out.

*Selection of plants.*—Plant material may consist of (*a*) ratoon suckers which come from the ground level, (*b*) suckers or sprouts which come from the parent plant above ground level and (*c*) slips which come from immediately under the base of the fruit. The suckers and sprouts are much more plentiful than slips, so for practical purposes let us keep to the firs two. These should be selected from strong and vigorous plants and detached when from 8 inches to 12 inches in growth. When detaching wear a strong leather glove and insert the thumb well down between the parent plant and sucker or sprout to ensure making the break right at the parent plant. Crowns should be selected for their smallness. Large crowns should be avoided as these indicate a large core. Crowns are cut from the fruit, not broken off.

*Treatment of plants prior to planting and planting.*—All plant material should be exposed to a strong sun, root end up, for at least seven days. These are then peeled, *i.e.*, about six or eight of the small leaves removed and the stalk cut square off. They are then ready for planting. Two rows planting 18 inches by 18 inches with 4 inches spacing gives about 8,600 to the acre; three row planting 12,400 and four row 13,600 to the acre. The mass planting gives an increased tonnage with a decreased diameter of the fruit, which is desired by the factory. A great deal could be written on the subject, but for practical purposes the above should be sufficient to meet all preliminaries.

*Weeding.*—Pineapples should be kept fairly clean of weeds, and by hand this will cost anything from 17s. 6d. to 25s. per acre for each weeding. The rainfall usually regulates the number of weedings necessary and that all important factor known as experience.

*Harvesting.*—Again experience only can teach when to harvest. This fact, however, must be remembered: the pineapple stores its starch in the stem which attaches it to the plant, and it is not until the fruit commences to ripen that the starch is converted into sugar and absorbed by the fruit. Therefore, if a green or partly ripe fruit is removed from the stem, the process of sweetening is at once arrested. If planters supply or attemp to supply unripe fruit to the factory they will be met with a withering blast from the canner, because he has to add cane sugar to make up the deficiency of fruit sugar.

*Transport.*—Handle ripe pines as you would a basket of thin shelled eggs. Bruised fruit is " unfit for canning " and in that expression are a mountain of argument, hard words and strife and a smaller cheque than anticipated.

In conclusion the only fruit which is " fit for canning " is the lucious pineapple known as the " Smooth Cayenne."

*Mr. Riaz.*—In the absence of Mr. Godfrey Garrick it has devolved upon me to speak on the important subject of the Pineapple Growning and Canning Industry in Fiji.

It appears to me that there are three heads under which the pineapple business should be dealt with—growing, manufacture, advertising and marketing.

That Fiji can grow a pineapple suited in every way for canning is an established fact. This being so we have only to decide on what is the type of soil most suited to the requirements of the plants, and what method of cultivation should be adopted. Generally speaking, the pineapple in common with all other cultivated crops requires that the soil be deeply and thoroughly ploughed and brought down to a fine tilth before the plants are put in. The pineapple plant, contrary to the belief widely held, has a deep rooting system. I myself have traced the roots to a depth of 2 feet. 6 inches. Intermediate cultivation should be carried out by pony-plough and scarifier until the plants are out of hand. Colour of the soil does not seem to give much indication of its fertility for pineapple growing, though it is as well to avoid planting on heavy black soils as indicating a high manganese content. This constituent in the soil is detrimental to the health of the plant.

Soils that carry a high oxide of iron content grow the healthiest plants and produce the soundest fruit. The plants like a fairly high acid soil, but good drainage and dry feet are absolutely necessary. Sloping land is the most suitable, with small catchment drains dug around the tops of cultivations, and a system of contour planting should be carried out, *i.e.*, the rows should be across the slope of the land and *not* up and down the hill sides.

*Preparation of plant material.*—The experience on Votualevu, Nadi, is that just as good, or maybe slightly better results are obtained if the suckers are put in directly they are detached from the mother plants without sun-drying or stripping off any of the leaves. Only one of our growers strips the leaves off his suckers, and he does not seem to have had fewer losses from plants dying after planting than other growers. This gentlemen has planted close upon 100,000 plants this year with a loss from death of 30 plants. The total number planted for the year is in the vicinity of 600,000 with a total loss of 100 plants through rot, so it would appear that on the score of cheapness it is better to avoid the expense involved in the stripping, extra handling and sun-drying of plants. We strip all plants off the main plant leaving all shoots from the ground for the bearing of the ratoon fruit.

*Harvesting.*—Like all other fruit the pineapple must be handled carefully when being harvested, and during transportation to the cannery. The fruit should be left on the stalk until the colour is showing yellow for about half way up the fruit. If these points are observed the fruit may be kept for as long as 10 days without deterioration. Bruised fruit ferments rapidly, and is therefore not suitable for canning if it has been harvested over 12 hours.

*Out-put.*—Within the space of 10 years from now my Company, by natural expansions from our own plant supplies, will be faced with the problem of having to handle 1,000,000 cases of canned pineapples. Then comes the most important question of cheap supplies of Empire cans, automatice pineapple-canning machinery, advertising, marketing and cheap freights.

*Empire can supplies.*—Up-to-date British can manufacturers have not been prepared to supply collapsed can bodies and covers, and we have therefore been forced to obtain our supplies from the American Can Company.

*Can reforming machinery.*—Can reforming machinery and closing machines have had to be hired from the American Can Company, which necessitates our purchasing spares from that Company, all of which are manufactured in America, and therefore have to bear heavy duty.

*Canning machinery.*—In the past we have had to purchase all our canning machinery from America at high cost and after the 28th June next, just when we will be entering into our first period of expansion, we will be faced with having to import from that country large quantities of canning machinery without the benefit of a rebate of the duty levied on such machinery, because that concession expires on that date. As there does not appear to be much chance of British Manufacturers giving us this type of machinery before the 28th June, 1932, this may not be an inopportune time to suggest that the Government extend the period for a further two years, *i.e.*, to the 28th June, 1934.

*Freights.*—At present freights to overseas markets are too high, but doubtless when we have large shipments to despatch we will be able to obtain more advantageous rates, and so this problem will in a measure solve itself.

*Marketing.*—The old saying " that though a man live in the middle of a forest, if he makes a better mouse-trap than another man the public will wear a footpath to his door " is well answered by " early to bed and early to rise is not worth a cuss if you don't advertise." Whilst not saying that we in Fiji can put up a better canned pineapple than the other man, I do say that we can put up just as good—but the other chap has a long lead on us, and the only way to catch up to him is for us to continue putting up a good article, and advertise and continue to advertise. This will mean entering into an extensive advertising campaign throughout Great Britain and Canada and the Continet. Now, this will mean that we will require a large amount of money, and I doubt if the Companies operating in Fiji can finance such an undertaking, though it is vitally necessary, not only to the welfare of the Companies concerned, but to the Colony as a whole, that such a campaign should be launched with as little delay as possible. I think that I am not being optimistic in estimating the possible out-put by the two Companies at present operating in Fiji will, inside 10 years, reach 2,500,000 cases. I will not go into figures, but leave it to you gentlemen to calculate the benefit that will be derived by the Colony in revenue, not to mention the cash put into circulation by such a quantity of fruit being canned in Fiji. I may state that the Empire marketing Board has only recently assisted the Colony of Mauritius to the extent of obtaining 300,000 pineapple tops from Hawaii for the purpose of assisting the people there to establish a pineapple canning industry. This cannot entail a lesser outlay than £5,000 when all costs are taken into account. The Queensland Government have lately decided to assist the export of canned pines to the extent of £20,000. These facts embolden me to suggest that the Government interest some such body as the Empire Marketing Board in assisting to finance such a scheme, such finance to be repaid by making a special levy of a certain amount per case canned.

In conclusion Mr. Riaz mentioned the fact that the Canadian market now required Certificates under the Pure Foods Ordinance 1925 and suggested that the Government should bring this Ordinance into operation forthwith.

*Mr. Ricketts* said that he did not agree with some of Mr. Riaz's statements regarding the cultivation of pineapples. He pinted out the fact that at Nadi it was possible to cultivate by machinery, but that at Waidau the land was fallen bush country too steep to work with ploughs and also covered with stumps, which would probably disappear in three or four years. For these reasons the Waidau pineapples were cultivated with mattocks and shallow cultivation by making a small hole, and this method had been found most successful. One difficulty experienced at Waidau was to get a pine small enough in weight to suit the small tins required by the trade. Pines weighing up to 9 or 10 ℔ were grown on Ovalau and there was too much waste. The ideal pine for canning weighed about 3½ to 4½ ℔.

*Mr. J. L. Hunt* said that he must congratulate Mr. Surridge on the very able paper which he had put before the Conference on the matter of Supplementary Crops. He remarked that if Mr. Surridge could guarantee £200 per acre return per annum there would be plenty of people anxious to come to Fiji. He himself would be very glad to know what the crop was. The important thing was not to tell growers how to grow their crops but to tell them how to market their crops and what their return would be. He did not think it wise to put an additional tax on bananas at the present time. As he had said in his paper there were practically no Europeans producing bananas at the present time, but he did not see any reason why there should not be if Europeans could be assured that bananas could be produced free of disease. Disease was the big bug-bear at the present moment and Europeans did not want to plant up bananas that would only last 12—18 months. He said that conditions had improved since the floods of 1929 and 1930 and there had been a reviving interest amongst European planters. He agreed with Major Joske that the cultivation of kumalas, Mauritius beans, maize, &c., were more suited to the Indian, Fijian and Chinese population. The big thing was to produce the crop in Fiji when the prices were highest on the market. He said that the question of grading was a very serious one. So far as the European was concerned there was no trouble if he were the producer because it was in his interests to see that the material was properly graded. The European purchaser of native fruit had to travel over large areas in order to collect the fruit and although the quantity might only be 500 cases the number of individual owners might be anything up to 50. For this reason it would be easily understood how difficult it was to grade on the packing stations. Mr. Hunt remarked that another big difficulty was the fact that the producer wanted too much for his produce. If the prices were reasonable the consumption would be larger and this would compensate the grower because he would be able to dispose of a greater quantity of produce. In conclusion he urged upon the Government to demonstrate by experiments the crops which could be grown, the cost of production and the return to be expected from them.

*Mr. Pearson* (Secretary for Indian Affairs) said that he would like to join with Major Joske and Mr. Hunt in congratulating the Conference on having secured from Mr. Surridge such an admirable and illuminating paper on the subject of Supplementary Crops. He felt that the paper dealt with all aspects of production, marketing, grading, &c., and he would like to have the paper sent to the Natabua Training School and to have it translated into Hindustani for circulation amongst Indian growers. He said he was particularly interested in Mr. Surridge's remarks about the cultivation of grapes for the out-of-season market. He said that he knew something about the Channel Islands and he wondered if Fiji could not be the " Channel Islands " of New Zealand and Australia for out-of-season crops. Speaking on the question of rotation of crops he was inclined to the opinion that perhaps the Indian through tradition went in for too much variety. He was much interested in what had been said about tomatoes. He came from a part of England where tomatoes were grown in large quantities.

Apart from the fruit which was sent to the market there was the question of the collection of small and green tomatoes to be made into tomato chutney and he wondered if this industry could not be established in Fiji. Mr. Pearson said with regard to beans he was interested in this matter mainly from the point of view of rice growing, and he considered that the Indian farmer required some other bean crop to grow in the off season Another point in Mr. Surridge's paper which particularly interested him was the cultivation of the egg-plant. Mr. Pearson remarked that the egg plant was a delicious thing and it seemed possible that the cultivation of this could be extended in Fiji. Speaking on the question of co-operation Mr. Pearson said that he was associated with Mr. Barnes on a Committee which had been considering ways and means of encouraging co-operation amongst Indians. They had come to the conclusion that it would be necessary to move slowly in this matter and in the first instance to encourage the Indians in the establishment of suitable crops and then gradually work in a scheme of co-operation. He remarked that the officers of the Agricultural Department were doing splendid work in assisting the Indian comunity to produce crops which would be of benefit to them and he thought that organisers or superintendents were needed to organise the marketing of the produce. He considered that it would be possible for these organisers to get in touch with the small producers and to go into matters connected with production and marketing. During the discussion last year on minor crops Mr. McGowan has supplied some very useful information in connection with the production and marketing of minor crops. Mr. Pearson said that he wondered if concentration on overseas markets was not too marked. He considered that one remedy for the present depression was concentration on the home market and production for home consumption. There was no doubt that the returns would show that the value of products imported into Fiji ran into a very considerable amount and there seemed to be no reason why some of these products could not be grown in Fiji and not only keep the money in the country by cheapen the price of the commodity. He mentioned one commodity, ghee, and said that lately the Indian settlers had become quite enthusiastic about the local product which was much superior to the imported article and also much cheaper.

*Mr. Wastall* said that he had great admiration for the work which the Agricultural Department had undertaken during the last few years. One thing he would like to mention was the maize-meal bread which the Department had distributed at the Show and he felt that there was no reason why we should not make the bread in Fiji instead of importing the wheat flour. He agreed with all Mr. Surridge had said and also wished to join with the previous speakers in congratulating Mr. Surridge on the excellent paper which he had presented. He maintained that Fiji would not progress until there were more European settlers. He emphasised the fact that there was plenty of room for anyone who went about it in the right way to do well on the land in Fiji. Turning to the question of beans he drew attention to the fact that rice bean was valuable in three ways, namely, cover crop, seed producer, and as an edible product. He understood that the Colonial Sugar Refining Company were at the present time using large quantities of rice bean as a cover crop and that it was being produced in Australia in place of the Mauritius bean. Nature produced about 7,000 orders of legumes of different varieties and he stressed particularly the advantages of the rice bean which produced prolifically; the crop could be picked every morning for three months and the bean was an excellent food for fowls as well as for man. There was another plant which he thought was indigenous to Fiji and that was the Nasau. It was a Solanum and no effort seemed to have been made to cultivate it in Fiji. He knew that the plant grew very freely.

*Mr. Barnes* said that the discussion on the paper presented by Mr. Surridge had gone on for some considerable time and perhaps it was opportune to say a few words in order to clear up a few misapprehensions which might have arisen after the remarks of some of the speakers. He said that the object of the paper was not so much to stimulate Europeans to take up supplementary crops, but to put into a concrete form information which had been collected by the Agricultural Department, mainly by Mr. Surridge on the production and marketing of crops which were being grown to an increasing extent by Chinese and Indians in the Colony. He said that unfortunately the Chinese Consul found himself unable to contribute to the discussion, although he was present at the Conference, but he had expressed the keenest interest in this subject, and had promised to use his influence. Major Joske in the course of his remarks suggested the co-operation of the Chinese Consul and certain Departmental Heads of Governments. Mr. Barnes informed the Conference that at the present time there was the Agricultural Advisory Committee, which unfortunately had not the assistance of the Chinese Consul, but it included the Secretary for Indian Affairs, the Secretary for Native Affairs, also the Director of Education who could give much assistance in connection with the training of school children in agriculture. He thought that the idea of a Fijian Agricultural Conference was an excellent one. The opportunity was taken during the Annual Meeting of the Young Fijian Society to deliver an address on matters closely concerning Fijian agriculture. The Department of Agriculture had carried on work on the questions that had been suggested at previous Conferences and one object of the Conferences was to indicate the results of investigations. One of the difficulties which had been experienced was the securing of proper seed, but shortly it was hoped that the Department would be in a position to distribute a limited quantity of various seeds. Referring to the pineapple paper Mr. Barnes said that there appeared to be some difference of opinion, perhaps not so serious as one might think, between the people who were planting at Waidau and those planting at Nadi. It was evident that the Waidau people had been very successful in producing fruit with shallow cultivation.

*Mr. Barnes* read the salient points of the Paper* on the "Citrus Exports—Experimental Shipments," and said that Fiji was particularly favourably placed in regard to citrus exports because of the possibility of getting fruit of good quality on to the New Zealand market when none other was available and to Vancouver market after the New Zealand market had become weak. The system of preferences within the Empire should go still further to encourage the development of this industry. He remarked that he saw little prospect of Europeans taking any large part in the actual growing of the citrus fruits, for some time but the Agricultural Department had imported varieties of citrus and had also secured plants of varieties scattered throughout the Colony which were known to be very popular in the export market.

*Mr. Barnes* in rising to close the Conference said that those who had been responsible for the organising of it had been very gratified at the interest evinced in the subjects dealt with. He thought that perhaps the information which had come to light during the discussion on the Stock Industry was the most important aspect of the Conference, and points had arisen which would be given early attention. The present Conference had been organised on similar lines to those of the first Conference and the idea was to let the public know the results which had been achieved in the course of inquiries pursued by the Agricultural Department. He wished to make it quite clear that the Department did not seek publicity, that the object of the Conferences was not to boost the Department, but he felt that it was the duty of the Agricultural Department to take the public into its confidence from time to time and to let them know what had taken place. Speaking on the question of publicity which had been raised by at least two contributors to the discussions he thought that the question of advertising Fiji bananas and Fiji produce might well be referred to the Fiji Publicity Board. For the past 15 or 18 months he had been Chairman of that Board and the question of advertising Fiji and also its products had been very closely before the Board. He mentioned that the Board had offered a prize of £5 for the best poster advertisement of Fiji, and the poster which had won the prize had something to do with all the industries of Fiji which had been briefly touched upon, and illustrated the keen observation of the person who had designed it. Mr. Barnes said that on behalf of the organising Committee he wished to express the thanks of the Conference to His Excellency the Governor for the keen interest which he had continued to take in the Conferences and also for his presence during a number of the discussions. Thanks were also due to the Suva Municipal Council for so kindly placing the Town Hall at the disposal of the Organising Committee. He also wished to thank Mr. McHugh, the Government Printer, who had gone to considerable trouble in the preparation of papers for presentation to the Conference. In conclusion Mr. Barnes extended thanks of the Organising Committee to all those who had prepared papers for the Conference and to those who had attended the meetings and had taken part in the discussions.

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*Major Joske* said that the thanks of the Organising Committee, consisting of Messrs. J. L. Hunt and E. Duncan and himself were due to Mr. Barnes on whose shoulders had fallen the duty of organising the Conference. He remarked that all the Organising Committee had done was to attend a meeting at Mr. Barnes' office at 2.15 p.m. one day and say, "Yes, yes, go ahead." He said that the efforts of the Agricultural Department were fully appreciated by the presence at the Conference of His Excellency the Governor. In conclusion he would move a hearty vote of thanks to Mr. Barnes and the members of his staff who had been responsible for such an interesting and instructive Conference. (Carried by acclamation).

## FORESTRY IN FIJI.

By R. A. SYKES, Conservator of Forests, Fiji.

PRIMITIVE man in the tropics looks to the forest for almost all the necessaries of life which are not provided by his field crops and domestic animals. From it he obtains materials for his house and furniture, fuel, clothing, lighting, weapons, cordage, medicines, edible fruits, game and birds, and numerous other products which play a part in his daily life. Moreover the forests provide him with a large reserve of fertile land indispensable for his primitive system of agriculture.

The arrival of the white man with his civilising and developing influence at once results in a heavy drain on the forest. Large areas of forest land are cleared for agricultural development, and a demand arises for timber for constructional work, roads, railways, domestic purposes, cases for agricultural products and fuel. Further, white rule, bringing with it the blessings of peace and improved hygiene, stimulates a rapid increase in the native population and proportionate increased activity in native agriculture. The consequence in some parts of the tropics is forest destruction on a grand scale at the hands of native agriculturists practising " shifting cultivation," the only system of agriculture known to them.

The most obvious effect of this drain on the forest is the increasing scarcity in accessible situations of the more valuable timber trees. This in itself may be a serious matter but there are other more subtle effects, and unfortunately these too often do not become apparent until it is too late to remedy the situation by immediate action.

It is perhaps not sufficiently well known that the forests of a country have a decisive influence on its climate, particularly in the matter of rainfall. It may be thought that this influence is negligible in a Colony such as Fiji, consisting of a number of small islands enjoying an " ocean " type of climate; but that forests cannot be destroyed with impunity even on Pacific islands may be judged from Guppy's comparison of the rainfall in Hawaii with that in Fiji. Writing of a visit to Hawaii, he says:—*

> " The consequence of unchecked destruction of the forests was in my time becoming only too evident. When I passed through Ookala on the Hamakua Coast at the end of May, 1897, there was a water famine. Water was sold at a quarter of a dollar a bucket, and the allowance for a family was three oilcans a week. . . . . . Originally forests covered the upland plateaux and mountain slopes of all the islands. Now much of the original forests has been removed and large areas of naked soils and bare rocks remain. The present forest area is about 20 per cent. of the islands, a small fraction of what it was a hundred years ago. It is, however, very satisfactory to learn that American energy is combating this evil. . . . . . Hawaii owes much to the United States Department of Agriculture. May we in England take the cue in the case of our own Crown Colonies ! "

Referring to the climate of Fiji he writes:—

> " Fortunately the Fijian Islands have not been long enough occupied by the whites to produce much effect on the rainfall through the destruction of the forests. A significant warning, however, has been given in the vicinity of Levuka. The woods of the hills around the town, as we learn from Mr. Horne, were cut down to prevent them from affording shelter to the unfriendly natives of the interior, the result being to reduce the number of rainy days in a few years from 256 to 149 per annum."

From the above extracts it will be appreciated that deforestation may not only cause a substantial decrease in the total precipitation of rainfall, but may also bring about a variation in its incidence. The effect of such climatic changes on agricultural operations is obvious.

The forests on mountain slopes are of value in another way. The foliage of the trees protects the ground from the mechanical disintegrating effect of heavy rain, and the forest soil below, rich in vegetable matter, acts as a sponge which absorbs the water gradually and gradually releases it. Not until this soil becomes saturated is there danger of serious flooding. A heavy downpour of rain will produce no effect more serious than a slight rise in the level of the rivers, and in periods of drought the rivers will fall gradually, drawing on the reserves of water held in the spongy soil of the forests. Now compare the situation which occurs when a mountain has been deforested. Then every storm will be the signal for the appearance of innumerable torrents which eat out their course as they flow, often laying bare the naked rock beneath. The main river of the system may be unequal to the sudden strain, and overflowing its banks, flood the lower plains with its silt-charged waters. After the storm the flood will subside as rapidly as it began. In dry periods the river having no reserves of water to draw on may be reduced to a mere trickle or even dry up altogether. Our experiences in February are too fresh in our minds for us to underestimate the disastrous effects on agriculture of frequent and severe floods.

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* *Observations of a Naturalist in the Pacific*, Vol. II, H. B. Guppy.

## PART II.

The British are historically a race of forest destroyers. The forests of the Homeland have long ago practically disappeared, and in all the big Dominions and Colonies with the exception of India they have been regarded up to quite recent years either as a nuisance to be cleared away with all speed to make way for agricultural and industrial development or as an asset which no amount of exploitation can exhaust. It is a British characteristic to live in the present and let the future look after itself, with the comfortable assurance that when the inevitable crisis does come along we will " muddle through " somehow. The War gave this complacent attitude a rude shock in many directions, and among other matters focussed the attention of statesmen in all parts of the Empire on the results of the past improvident destruction of our timber assets. The need for constructive action was further emphasised by the warnings of high authorities who have been examining the World's resources and consumption of softwoods. Mr. Fraser Storey, of the Forestry Commission, London, after a statistical survey of the position, has stated that a serious shortage in the World's supply of softwoods is likely to occur in about 40 years' time. The gravity of this statement will be appreciated when it is realised that the production of a mature spruce tree may take anything from 70 to 120 years.

India has long been a shining example to the rest of the Empire of the great advantages ensuing to the community from a sound forest administration, and of recent years the Home Country, the big Dominions and the larger Crown Colonies have been taking active steps to put their forest administration on a similar basis.

It will be realised from the above remarks that forest policy has both a national and an Imperial importance. Further, it is of the nature of forestry that its returns are slow, that the individual can very rarely hope to reap what he has sown. A forest policy must have continuity over a very long period of years, more than three generations of men. Experience has shown that the task of framing and carrying out such a policy cannot safely be left to private enterprise. Governments alone have the necessary continuity and ability to take the long view, and are not so prone to the temptation to take an immediate profit at the expense of future generations.

In countries where systematic forest management has been in force for centuries, for example, France, Germany and Switzerland, the forests are a great national asset and yield a substantial nett annual revenue to the State. This is true also of India, whose forest administration dates back a mere sixty years or so.

In the early stages of forest administration, particularly if, as is almost invariably the case, the forests have been exposed for a prolonged period to uncontrolled felling, expenditure will in all probability exceed revenue for a number of years. As in any other form of production a certain amount of capital must be invested to secure a return. It is therefore desirable that the individual citizen who pays for the service should understand the importance of a forest policy, its aims and, as far as possible, the means whereby it is to be carried out.

In a country such as Fiji, the primary objects of forest management would be as follows:—

(i) to provide a sustained annual yield of timber and fuel sufficient for all future requirements;

(ii) to maintain an area of forest sufficient to ensure an adequate rainfall, and to reduce the risks of flooding and erosion by controlling .the run-off in mountainous country.

Secondary objects would be to provide catchment areas for local water supplies, and to preserve the amenities of the countryside by protecting beautiful tracts. Anyone who has seen the devastation in the neighbourhood of the Prince's Road near Suva may indeed be inclined to regard this last as of primary rather than secondary importance.

The first need of a Government embarking on a forest policy is to have control of forests or at least afforestable land. To this end permanent forest estates or forest reserves are created. In other tropical countries it has been found that reservation of 25 to 30 per cent. of the total land area is sufficient to ensure that the objects of the policy are realised. Forest reserves may be constituted on land already held by the Crown, or they may be acquired in some other manner.

The great proportion of forest land in a British Crown Colony is usually owned by the natives. In Nigeria, where the natives own their land communally, forest reserves are as a rule acquired by agreement. The natives do not part with their ownership of the land but surrender the management of it to the Government. In return a proportion of the revenue obtained from the forests is paid into native funds. Government have powers to acquire forest reserves compulsorily if it is considered necessary and if the native owners are unwilling to surrender control by agreement. It will be understood that there is difficulty in persuading a primitive people to surrender control of their land for objects which they find hard to understand and with which in any case they have little sympathy, but this antipathy will gradually disappear as the revenue from the reserves under systematic management increases, and as the forests which are not reserved are destroyed.

Selection of the reserves and their subsequent working to obtain the maximum sustained yield can only be undertaken by experts.

## PART III.

My survey of the Fiji forests is not yet complete, but it may be of interest to set down some of the impressions which I have received so far. The arrival of the European has not been attended in Fiji by that wholsesale clearing of forest lands which is such a marked feature of his advent in other parts of the tropics. European development has been slow and has been more or less confined to areas of low elevation in the coastal districts. The Fijian farmer, though he is a shifting cultivator, has not made any serious inroads into the forest. His population is comparatively small and is not increasing rapidly. In fact, I received the impression in some districts that there was a tendency to migrate from the villages of the hinterland to the coast. In short the greatest destruction of forest has occurred in the lowerlying developed districts at the hands of European, Indian and Chinese settlers. Old residents have informed me that the amount of silt deposited in the channel of the lower Rewa appears to have been increasing of recent years and there can be no doubt that this is due to increased erosion in the basin of that river consequent on intensive settlement. Elsewhere, so far as my inspection has gone, there does not appear to be any urgent present need of forest conservation with the primary object of stabilising the climate or preventing erosion. At the same time there is not, so far as I am aware, any legal machinery to check extensive deforestation at high altitudes and in view of the irremediable character and possible disastrous consequences to the agricultural community of such action, the situation requires careful watching.

Now let us consider the position from the standpoint of timber supplies.

Our imports of timber for the year 1929 (a more normal year than 1930) consisted of about 10,500 tons of softwoods and 2,000 tons of hardwoods. The out-turn of sawn timber from local mills is estimated to have been about 8,000 tons and of timber cut for other purposes including native consumption and fuel, about 50,000 tons. The total estimated consumption was thus 70,500 tons, of which our own forests provided about 58,000 tons. This reckoning does not take into account imports of wood in a manufactured form, such as furniture, paper, artificial silk, &c.

The wood consumption per caput of a community is an index of its standard of civilisation, and in a new country the increase in consumption over a period of years is also a guide to the rate of development. The present depression has no doubt slowed down consumption considerably, but when normal times return we may expect a steady expansion in the annual consumption, due to European development, increase in population and improvement in the standard of living of the native races.

Fiji is therefore faced with (1) the probability of an increasing internal demand for timber of all kinds, and (2) the prospect in the not too distant future of a shortage in the external supply, particularly of softwoods. In these circumstances it is wise to take stock of our own resources.

Fiji is fortunate in having in her forests woods suitable for almost every purpose. The following are our more important woods classified according to usage:—

*Hardwoods.*—Buabua, Vesi, Yasi, Sacau, Savai, Vuga.
*Medium hardwoods.*—Yaka, Bauvudi, Damanu, Rosawa.
*Softwoods.*—Kauri, Dakua Salusalu.
*Casewoods.*—Kauvula, Kaudamu.
*Fuels.*—Dogo, Nokonoko, Caukuro.
*Luxury wood.*—Sandalwood.

Of the hardwoods, Buabua and Vesi are the most sought after. Both have a limited range, and consumption, particularly of Buabua, probably exceeds production. Sacau and Vuga are mountain trees and not being easily accessible are not much cut. Yasi, of which there are many kinds, is in good supply over most of the forest area. Savai is in fair supply in Vanualevu, less so in Vitilevu.

Of the medium hardwoods, Yaka is at once the most sought after and appears to have the most limited range of any tree in Fiji. It does not regenerate well without assistance, and exhaustion of the more accessible stands of Yaka appears to be a matter of time. Damanu is a common tree in better quality forest throughout the group. Bauvudi, though not so common as Damanu, is in fair supply. Rosawa is rather rare and grows usually at high, not easily accessible elevations.

Of the softwoods, the Kauri has been heavily cut where reasonably accessible. It is widely distributed over the mountain ridges of the islands, and in a few localities it may furnish about 60 per cent. of the millable volume. It does not regenerate well without assistance, but the seedlings of the tree are fairly hardy when established. Dakua Salusalu is less widely distributed than the Kauri, and is common only in a few favoured localities. It regenerates freely, but the seedlings are quickly killed by lack of light and pressure of competition. Both these trees yield a timber equal, if not superior to, any imported softwood, provided that due attention is paid to seasoning, a matter which has been too often neglected.

The casewoods, Kauvula and Kaudamu, are in good supply. There are probably other woods suitable for this trade and the yield of the forest appears to be more than equal to the present demand.

Of the fuels, Dogo has been heavily cut in the neighbourhood of Suva, and exhaustion of the big timber of the Navua forests is in sight. There is still a large reserve of smaller sized fuel in the Rewa Delta. There has not been much exploitation of the other Dogo forests. The tree regenerates well and needs little assistance. Nokonoko and Caukuro are in good supply on the dry side of the islands.

Sandalwood in commercial sizes has practically disappeared, and even young saplings are exceedingly rare. This tree furnishes one of the most valuable woods in the world. Fiji has lost a valuable asset by allowing uncontrolled exploitation of her sandalwood forests.

It is a basic principle of forestry that the annual cut should not exceed the forest's capacity of production if the yield is to be maintained. The disappearance of sandalwood is due to non-observance of this principle, and it appears that supplies in accessible situations of Yaka, Kauri, Dakua [Salusalu], Buabua and possibly Vesi are dwindling for the same reason.

The danger with a situation of this sort is that it is not apparent until an acute crisis arises when it is probably too late to take effective remedial action. It is not, for example, expected that warning of the approaching shortage of softwoods will be given by a gradual increase in the prices of these woods. The reason is that the American mills, which hold the key to the position, are planned on the basis of an enormous output. Prices are therefore likely to remain comparatively stationary for some time and rise sharply in a series of jumps as these mills are put out of action one by one owing to failure in the supply.

The forests of Fiji are quite equal under scientific management to the task of supplying indefinitely all possible future requirements, and even of providing a balance of our better class woods for export. It is not proposed to describe here in detail the methods by which this desirable end can be accomplished, but it may be briefly indicated that improvement of [illegible] lands is effected mainly through cultural operations designed to increase the numbers of economic species in the forest rather than by clearing and planting. At the present time many of our forests are uneconomical to work on account of the low proportion in them of economic species. Improvement of such forests would present little difficulty to a professional forester.

An active policy of forest development would make productive lands which are at present practically worthless, would improve the internal communications of the Colony, and would provide a number of Europeans and natives with congenial employment. It is realised that it may not be financially possible to embark on such a policy at the present time, but this article will have served its purpose if it has brought to notice a situation which it may be dangerous to neglect.

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